Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Timely in 1931; Timelier Today

IN THE June 1931 *Instruments* there was published a 44-page article* which was the first systematic treatment of all classes and types of industrial timing and scheduling instruments. This article, therefore, was a potential history-maker. Fortunately it was given its chance and it did make history, for four reasons: (1) Because of its informative value. (2) Because ten thousand copies of the June 1931 issue were printed and circulated throughout all industries, reaching the great majority of instrument-minded executives and engineers. Because industrial production was so low that these men were not too busy to study the long article, experiment with a few simple time control devices and order special-purpose controllers — or at least prepare in 1931-32 the specification to be sent out when industry would begin to recover. (4) Because instrument-makers likewise saw the possibilities and were ready when industrial production began to shoot up in 1933.

Result: it was in 1933-35 that time control instrumentation displayed its most phenomenal growth and diversification. Increasing use of these instruments aided industry to produce more and better things, at lower prices and at higher profits.

Today, industry's chief problem is not to create and woo profitable markets but to make more and more Defense products, faster and faster, so that the Arsenal of Democracy will not suffer from the deadly disease known as "too-little-and-too-late." That is why this issue is devoted to descriptions of devices which can help to step up the time-rate of America's productiveness. The need for information on timing and scheduling instruments is more vital than it was ten years ago. Since today's need springs from different conditions, the type of presentation is different, but essentials remain. Therefore, portions of the 1931 article are interspersed among up-to-the-minute descriptions.

The Silver Anniversary of Modern Fluid Metering

Since June 1916 when it was organized with R. J. S. Pigott as Chairman, the A.S.M.E. Special Research Committee on Fluid Meters has not merely kept up with advances in flowmeter technique but has promoted progress year after year. Its reports have been and are the bible of flowmeter users. There are two reasons for this outstanding success. One is Pigott's inspiring Chairmanship and masterly leadership of *this* committee all these years. The other reason is that in 1914 (at the age of 28!) Pigott had transformed the *Main* Research Committee from a dead ornament to a live organization; replaced "famous names" by executives; created the scheme of special research committees; and devised methods of raising ample funds for each research project. We believe that this quarter-century of fruitful achievements should be celebrated—and by a wider circle than the A.S.M.E. membership, because this work has enriched every technical field and because Pigott's co-workers have represented all these fields. Some engineers we tried to line up said that a meeting is out of the question these days. If so, the celebration will have to be "on paper" . . . and we hereby open it on this page in the name of thousands of *Instruments* readers who have reason to be grateful to the FMR Committee. Their salute, in their language, is as follows: "In 1916, errors of 30% were not unknown; to day, a 3% error is not tolerated and 1% accuracy is the rule. Well done!"

Problems change; Elements don't

In normal times, the usual problem is to produce a better item for less money. Industry's problem today is to turn out more units of each item ordered by the War and Navy Departments per unit of productivity (plant × crew), *per unit of time* regardless (or almost regardless) of units of currency. On the surface the two problems are radically different. But when they are resolved into their elements, it may be seen that certain time elements remain unchanged. A crude way of expressing the idea is this: To transform the equations of normal-conditions problems into those of emergency problems, apply the identity "Time is Money."

It is because time is money that under normal conditions the application of automatic time control instruments effects money savings. Therefore, since these instruments save money under normal conditions, they can increase the time-rate of production in this emergency.

But these assertions are too sweeping to be convincing. The reader doesn't believe that he can turn to any of the following pages, order a gadget, install it in his plant, and . . . presto, the Axis Powers are licked! Let us look into the principal phases of the subject. First, let's define the subject. What do we mean by Time Control? The control of time is a metaphysical fantasy. All we can do in industry is to control the performance of men and equipment while time flies.

This is done most directly, of course, by temperature controllers, pressure controllers, and so on. But time itself is a processing or operating condition, as are temperature, flow, humidity and the other familiar "controllables." Just as there is One Best temperature for any process, so is there One Best duration — as is known to anyone who has boiled eggs, or taken photographs. Practical examples will occur to chemical engineers, steel treaters, textile dyers and finishers, rubber technologists, and to anyone connected with food-product industries. In all such processes the One Best duration is not the shortest; and mere speeding-up would spoil the products.

Another industrial aspect of time is the division of total duration into intervals or periods, as suggested by the words "sequence" and "schedule." It may be called time management and its relation to speed of production is obvious because without proper synchronization in any plant, some of the men and of the equipment will wait idly during part of the time.

What Time Controllers Do

In the following pages there will be found numerous forms of automatic time controllers. It may be helpful to classify them here by what they do. One convenient scheme is to distinguish between snap ("on" and "off") actions and gradual changes. This gives three classes, the third being the combination:

I. *Snap Actions or Impulses.*—(1) A sequence in which all intervals between impulses are definite; all adjustable together. (2) A sequence in which some intervals are adjustable together, independently of the other intervals: the "two-shaft" principle or its equivalent. (3) A sequence in which the schedule of starts is fixed, the durations of all started events being adjustable together. (4) A sequence in which some durations are dependent upon conditions other than time. Example, a cam stops unless the pressure in a certain part of the processing apparatus has dropped down to atmospheric; and the main sequence is resumed automatically—after seconds or *(Continued on page 186)*

* M. F. Behar, "Timing and Scheduling Instruments" (second part). *Instruments*, June 1931, pages 309-352. Some quotations, however, are from the first part (May 1931).

INSTRUMENTS' 1941 SYMPOSIUM OF

Automatic TIME Controllers

PNEUMATIC ELECTRICAL ELECTRONIC MECHANICAL HYDRAULIC

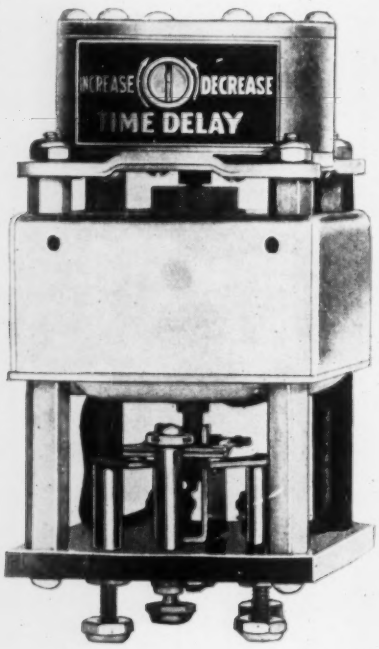
INTERVAL TIMERS TIME SWITCHES IMPULSE TIMERS CYCLE CONTROLLERS
PROGRAM CONTROLLERS TIME DELAY RELAYS SEQUENCE CONTROLLERS
AUTOMATIC TIME-TEMPERATURE, TIME-PRESSURE, ETC., CONTROLLERS

Introductory Editorial on preceding page; Quick-reference Index on page A-4

American Gas Accumulator Company

The "Agastat"

Purpose of this instrument is to introduce in electrical circuits a time delay adjustable from a fraction of a second to fifteen minutes. Time period is adjusted at factory. Timing principle is similar to that of the company's unattended marine lighthouses which flash more than ten million times a year for many years. Timing head contains two chambers connected by (a) an adjustable bleeding valve and (b) a



quick-release valve. Agastats are available for the control of a.c. or d.c. circuits, sixteen voltages being listed by maker. Agastats operate 15% of rated voltage but timing period is unaffected by voltage fluctuations. Electric switch portion is interchangeable, eighteen different contact arrangements being available. Various enclosures and mountings are available. Apart from all these varieties, however, Agastats are available in two distinct categories, designated "Group 1" and "Group 2."

The operation of a "Group 1" Agastat (arranged to function a predetermined time after the control circuit is *energized)* is in four steps: (1) When the control circuit is energized, the core makes complete stroke compressing the spring. (2) Spring compression is transmitted, through the spindle, to the compression diaphragm of the lower chamber in the timing head. This diaphragm slowly forces the gas from the lower chamber, through the (adjustable) bleeding valve, into the upper receiving chamber. (3) When the compression diaphragm reaches a fixed point in the upward stroke it trips the quick-release valve, permitting instantaneous passage of the remaining gas from lower to upper chamber. This causes a quick final movement of the spindle operating the snap action switch. (4) When the control circuit is de-energized, the weight of the core and the spindle assembly, together with the released spring tension, immediately recycles the unit, returning the compression diaphragm and contacts to their original position. This instantaneous movement draws the gas from the upper to the lower chamber through the quick-release valve. This valve then closes; the unit is ready for another operation.

The operation of a "Group 2" Agastat (arranged to function a predetermined time after the control circuit is de-energized) is in three steps: (1) When the control circuit is energized the core makes a complete stroke compressing the spring and transferring the switch from its normal position to the transferred position. (2) When the control circuit is de-energized, compression from the spring is transmitted through the spindle to the compression diaphragm of the lower chamber. The diaphragm slowly forces the gas from the lower chamber through the (adjustable) bleeding valve, into the upper receiving chamber. (3) When the compression diaphragm reaches a fixed point in the upward stroke it trips the quick-release valve, permitting instantaneous passage of remaining gas from lower to upper chamber. This causes a quick final movement of the spindle returning the snap action switch to normal position. The unit is then ready for another operation. However, if the control circuit is again closed before the expiration of the delay interval the switch will not return to normal until a complete delay interval has occurred.

American Schaeffer & Budenberg Instrument Div., Manning, Maxwell & Moore, Inc.

Interval Timer Feature for Temperature and Pressure Controllers

This manufacturer's air-operated automatic controllers (recording or non-recording) may be equipped with a timing device, the function of which is to hold the diaphragm-

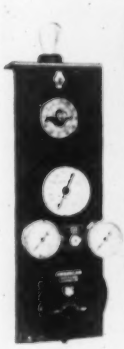


Fig. 1

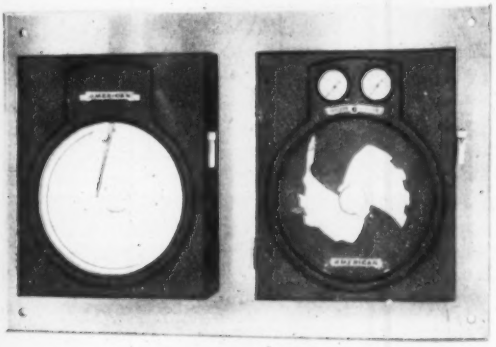


Fig. 2

...tor valve open (or shut) for a specific duration, irrespective of the temperature or pressure for which the ...troller has been set. The interval timer is mounted on ...e panel if used with a non-recording controller; it is ...ounted on the case of a recorder-controller; its dial ...ounted flush with the panel (see Fig. 1) or case.

...ime-temperature Control

..."*American Time-Temperature Controllers.*"—This is a ...ombination of an "American Recording Thermometer" and ... "Controlograph" with a cam. Both instruments are mounted on a steel panel (see Fig. 2) and both operate from the same thermostatic system. The cam itself is a reproduction of the chart on a round piece of metal. "Separate cams are inexpensive and easily cut."

American Timer Corporation

[EDITOR'S NOTE—No reply to repeated notices of this survey. Information below has been compiled from our files.]

"Sentinel" Timers

One model of these, though developed for household electrical appliances, appears to be suitable for timing plant and laboratory devices on 110-volt 60-cycle supply drawing up to 15 amps. It has two clock-like timing dials (for "on" and for "off" times) and a 4-point main control knob ("manual," "off," "on" and "set"). In operation, therefore, it closes a circuit at a predetermined time and opens it at another predetermined time; or it does both with one setting; or it performs either operation alone.

Automatic Electric Company

General Statement *(from letter transmitting selection of company's literature)*:

"Accurate time intervals can be provided for almost any purpose of electrical supervision, recording, or control, by the use of Automatic Electric relays or switches, or both, properly combined to meet specific requirements. These devices are described and illustrated in our Catalog of Electrical Control Apparatus [This is a 48-page book describing more than 100 items.—EDITOR]. The following brief notes may suggest some of their possibilities. The application of these products as timing devices is limited only by the ingenuity of the designers....

"Many timing requirements can be met very satisfactorily by merely making use of the time lag which occurs in the operation and release of a relay. The time intervals procurable in this manner vary from 0.002 second to three minutes, as shown in the specifications of the various relays ("Operate Time" is the delay procurable on the closing of the relay circuit; "Release Time" is the delay on the opening of the circuit). These delays are provided by the use of special relay coils, armatures, oil dashpots, contact springs, and other details of construction. Further delays can be secured by taking advantage of the charge and discharge time lag of condensers, or in various other ways.

"In other cases, it is required that a series of electrical impulses (momentary closings of an open circuit, or openings of a closed circuit) be produced at regular intervals. Such a series of impulses can be secured by combining three relays in a simple circuit arrangement, the time interval between pulses being determined by the characteristics of the relays used. By proper adjustment of the relays, and the use of condensers, dashpots, etc., time pulses can be secured to meet all usual requirements.

"Where time intervals must be exceptionally long, or where irregular intervals may be needed, rotary stepping switches may be used, responding to impulses produced in some manner such as the above, and transmitting an entirely independent series of pulses which are produced as the rotary switch reaches certain points in its rotation. With this method of pulsing, time intervals may be readily varied by proper selection of contacts, and two or more different series of pulses may be produced simultaneously....

"In the absence of a specific requirement, it is impossible to give more than a general outline of the possibilities in automatic timing with relays and switches. . . ."

Description of a Special Timer

[Condensed from article by D. C. Clegg in *Automatic Electric Review*, March 1940.]

Tucker and Andreas, Massachusetts Institute of Technology, developed a method of determining the surface tension of a liquid from a photograph of a pendant drop of the liquid. It was necessary to devise a method of operating the pendant drop camera automatically. The timing device had to possess great flexibility, since it would be required to perform under varying conditions. Its accuracy had to meet the requirements of a scientific laboratory. Several possible methods were pursued fruitlessly before a solution was hit upon, utilizing six standard Automatic Electric 25-point rotary switches, one 11-point switch, and a group of associated keys, relays, lamps, and solenoids. The equipment is assembled and wired in a compact unit, specifically designed to require a minimum of attention from the operator.

This unit, composed of ordinary electrical control equipment, is capable of measuring intervals successively by powers of two seconds (1-2-4-8-16-32-64 . . . 2^{12} seconds) as well as "common" intervals, such as 5, 10, 15, 30, and 60 minutes, and 2, 3, 4, 5, 6, 7, 8, 9, and 10 hours. At each of these intervals, electrical impulses operate the camera, except that at the operator's option the device is capable of skipping any operation. Provisions are also made for turning on the main exposure lamp three minutes before exposure time and off again after the exposure. For the first 2,474 seconds of operation, the main exposure lamp remains on. The operator is only required to set the instrument's manual controls for a preselected set of operations, and start it. The rest of the work is done automatically.

The timing is accomplished by a series of four 25-point stepping switches. Impulses generated by a synchronous motor move the first switch at the rate of one step per second. The second switch is driven by the first, and travels one step in 25 seconds, in turn driving the third switch one step in 625 seconds, which drives the fourth switch one step in 15,625 seconds. Two more 25-point stepping switches act as selectors to choose the set of contacts on the timing switches which will be energized at the desired time. These two selector switches are synchronized with the first timer switch to step once every second, also. Contacts on these selectors are chosen manually by means of lever keys. Thus the operator determines in advance at what time he wishes exposures made, and as the wipers of the two selectors pass over any chosen contact, a circuit is formed through the contact, through the contacts of the proper timing switches, and to the solenoid which then operates the camera shutter. The first selector switch selects powers of two seconds, as follows:

Interval	*Seconds*	*Switch No. 1*	*Switch No. 2*	*Switch No. 3*	*Switch No. 4*
1	1	1	0	0	0
2	2	2	0	0	0
3	4	4	0	0	0
4	8	8	0	0	0
5	16	16	0	0	0
6	32	7	1	0	0
7	64	14	2	0	0
8	128	3	5	0	0

and so forth. The list of "common" intervals is picked by selector switch No. 2.

Associated with the six 25-point switches is a network of relays and an 11-point stepping switch. This 11-point switch acts as a sequence switch to operate a solenoid connected to the camera shutter, following which it operates the plate-changing mechanism in proper sequence.

Although the control device was developed specifically for use with the M.I.T. research camera, it is applicable to any process requiring a series of electrical impulses at intervals which may be pre-selected by the operator, even though the operations extend over many hours of time.

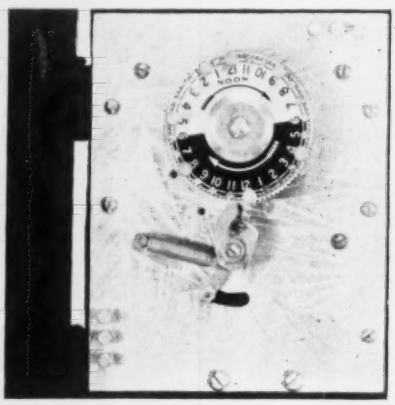
Automatic Electric Manufacturing Co.

General Classification

This company manufactures only automatic timers, etc.: "*Time Switches*—electrically and manually wound; *Flashers*—one-circuit, alternate color change, spellers, chasers, combinations, relays; *Interval Timers*—manual or automatic reset; *Program or Signal Timers*—manual or automatic reset; *Special Controls*."

Time Switches

These are ordinarily used for opening and closing circuits at set intervals in each 24 hours. The 24-hour dial is their distinctive feature. Other features of this company's Synchronous Time Switches are as follows: (1) Windows in all cabinets, visible dial and visible "new style" trip levers; bright for "on", black for "off"; (2) Interchangeable dials



for one or two sets of trip levers; (3) Self-starting synchronous motors operating at —20° F.; (4) Settings as close as 15 minutes between "on" and "off"; with two sets of trip levers, next "on" operation as close as 1h.45m.; (5) Motor-operation indicator; (6) Manual control. These features characterize all time switches; in addition, the Sunday and holiday cutout feature is standard on all 45-amp. models.

The regular models range from 7 to 45 amperes. The company manufactures also two extra-heavy-duty double-pole types: "No. 1250" rated 50 amps. per pole (100-amp. split load) and "No. 1290" rated 90 amps. per pole (180-amp. split load). These are known as Solenoid Time Switches. The clock is merely used to keep time and to provide circuit to operate the solenoid in the switch unit. The cabinet naturally is larger (15"×14"×4½").

"*Model 150-B*" is completely adjustable to provide either closed-circuit or open-circuit periods throughout 24 hours. Long and short pins can be placed in the dial. A long pin provides a period of one hour; a short pin a period of half an hour. Using these in combination provides any operating schedule wanted. Capacity, 10 amps.

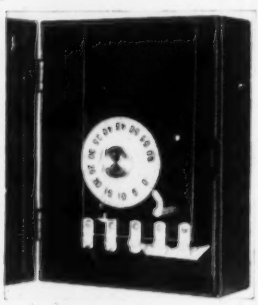
The company manufactures also small unenclosed time-switch units for installation in connection with the products of other manufacturers.

Interval or Process Timers

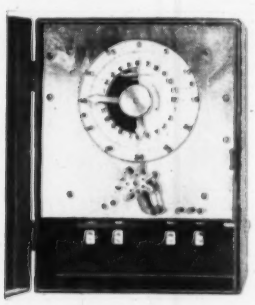
These are available with manual reset or with automatic reset, for practically any desired maximum length of time, or cycle. Both types are fully adjustable from zero to the maximum time. The steps by which a unit is adjustable depend on its maximum timing period, as these steps are proportionate. All are "special" to meet individual specifications, but all are similar in basic design and construction. They may be furnished with or without interconnection between Line and Load terminals. (Without interconnection it is possible for the timer to be installed on a.c. of one voltage and frequency and control a load operating on d.c. or a different a.c.)

Interval or Prbcess Timers with Manual Reset—These can be furnished for any cycle in seconds, minutes, hours or days. By turning the indicator hand to any desired point on the dial, the operator starts the timing motor and the indicator immediately starts traveling back toward "0." On reaching this point, the timer will either close an electrical circuit or open it, as specified in the order. In case of a current interruption, the timer will remain in position until power is resumed. It will then proceed to complete the time interval for which it was set. These timers are generally used to give a signal at the end of a set interval, such as a buzzer, light, etc. They can be furnished so that the signal is given continuously until shut off; or so that the signal will be given only for a specified number of seconds, from five up, and then shut off automatically—the timer remaining in this position, with everything "off," or the timer off and the appliance on (if so specified) until the operator again sets the indicator for the next interval to be timed, repeating the performance. These units can also be connected in series with appliances so that the timer will shut off the appliance as well as itself at the end of the interval. The indicator hand must be set manually for each interval or process to be timed. These timers are equipped with synchronous self-starting motors. They are furnished for a.c. only, and have a capacity up to ten amperes. Dimensions: 6½" × 7" × 3".

Interval or Process Timers with Automatic Reset—The operator sets the timer for the interval desired, and locks the dial in position. He then gets his process in readiness, and presses the button. This immediately starts the timing



Automatic-reset timer



Program timer

motor, and the dial begins rotating toward "0". On reaching this point the timer will open or close a circuit, shut itself off, automatically recycle to the starting position, and remain there until the button is again pressed, and the performance is repeated. In the event of a current interruption, these timers will automatically recycle, in readiness for the next operation when current resumes. Some units, however, can be furnished so that they will not recycle if the current is interrupted, but will remain in position and then complete the particular interval when the current is restored. A glass window leaves the dial visible. Dimensions: 8½" × 6½" × 4".

Program or Signal Timers

The Automatic Program or Signal Timer is designed for use in connection with a bell, horn, or other type of signal, for starting and stopping industrial or office work; in schools, etc. The signals can be arranged to occur at any specified schedule, permanently set at the factory. Either or both a "Manual Control" and a "Sunday & Holiday Cutout" can be furnished. Units with signals closer together than five minutes, or with a program adjustable by the user, must be quoted on individually.

Automatic Temperature Control Co., Inc.

Introductory Statement *(from letters transmitting selections of company's literature)*:

"We believe that we have the most complete line of time controls and that we have been manufacturing these instruments for a greater number of years . . . "

"Any kind of a job which involves the making and breaking of circuits on a certain program can be handled by any ATC timer having the right characteristics . . . by a Dial Timer or by a Cam Timer, depending on the requirements for adjustability of cycle and/or duration of contacts

to whether the adjustability should be 'infinite' or in steps by changing gears."

Regular Models

I. Classification by form is into (1) Dial and (2) Cam.

II. Each of these two forms may be divided into (1) Cycle-Stop, (2) Repeat-Cycle, (3) Combination.

III. Again, all may be divided into (1) Fixed, (2) Adjustable and (3) Combination. In the second group there are (1) Adjustable by steps and (2) Infinitely-adjustable.

There are numerous other classifications, some not covering the entire line. Among them:

IV—(1) Inside Adjustment, (2) Outside Adjustment.

V—Starting contacts made (1) Manually at instrument, (2) Manually away from instrument, (3) Mechanically, (4) By contact-type instrument.

VI—(1) Standard combination of reversible self-starting synchronous motor, visible index of elapsed time and other desirable features; (2) Simpler construction for low-cost requirements.

VII—(1) In standard enclosure; (2) Without enclosure, for mounting in customer's equipment.

Specials

Specially-engineered controllers have been manufactured for practically every industry in the country, and have consisted mostly of standard parts of regular models, plus whatever new parts had to be designed. Many of these specials, therefore, are in the process of being added to the ATC line of regular models. Other special jobs, however, though consisting largely of standard parts, are not likely to become catalog items because each of them is—as a rule—a relatively large, heavy and elaborate installation. An example is the controller for a hazardous and complicated industrial process wherein forty mechanical displacements are required to direct and time various physical and chemical actions under rigid control of sequence and duration, thus necessitating a 270-circuit control system consisting of a 270-circuit timer (weighing over 700 lbs.) and a switchboard with 270 jack connectors.

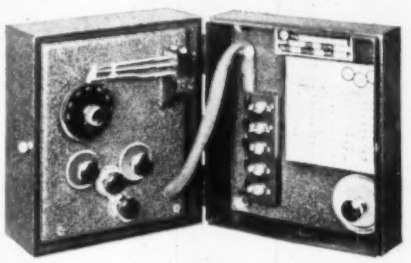


Fig. 1

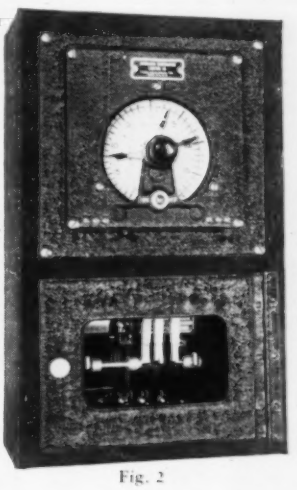


Fig. 2

Fig. 3

Cycle-Stop Dial Type Controls

Owing to the large variety of these controls, their characteristics are summarized by means of five charts and supplementary notes in a four-page bulletin. Suffice it to mention that Classifications IV, V, VI and VII, as given above under "Regular Models," are applicable. In brief, there are twelve distinct types of these controls.

Repeat Cycle Timers Series 4100

This is a cam type, operated by "Telechron" or "Haydon" synchronous motor (depending on time range). A motor-protecting feature disconnects the motor on overload. This timer will repeat a selected cycle in any total period when current is supplied to the terminals. Adjustment of a split cam offers an infinite choice of settings for time-contact-held from 0 to 100% of the total cycle. The cam, conveniently located, is easily adjusted, and has the ability to retain the setting when the timer is subjected to vibration. Six ranges for total time are available with standard gear trains as follows: (a) 5 seconds to 80 seconds, (b) 1 minute to 16 minutes, (c) 3 minutes to 48 minutes, (d) 5 minutes to 80 minutes, (e) 1 hour to 16 hours, (f) 3 hours to 48 hours. Nineteen steps of total time are available in each of these standard ranges. Gear changing is accomplished quickly without tools and can ordinarily be completed in a few seconds. Special gears, quickly furnished, offer a great variety of total cycle ranges up to 12 months and more.

Controllers for Firing Programs, etc.

Fig. 2 shows a type, known as "*Class 2703*," which is widely used when it is desirable to have, in one instrument, the means of controlling the sequence and duration of all essential actions in a firing program. With this timer the firing at each end of the furnace is subject to individual adjustment by the turning of an external knob. Elapsed firing time is indicated by the progress of one hand on the visible dial. Individual actions, such as the operation of valves and dampers are governed by cams which are readily adjusted to the exactly desired time for actuation and duration.

Vernier-setting Series 2800 Type 2803

This type is distinguished by a vernier setting, whereby time cycles can be set to tenths of least scale division. It has been developed for industrial processes, automatic machinery and research-laboratory work. Four arrangements of load circuits can be effected, the resultant possibilities being so varied that they are described by means of tabular and symbolic presentation (in Section F of Bulletin T-20). These load-circuit changes are made without tools and without dismounting timer: by adjusting slides and by locating bridge connections. Four dial ranges: 2/15/20/60 min., are available, with 80 to 120 scale divisions. Silver contacts carry 30 amps. at 110 volts a.c. The motor is "Telechron." This type is available in any of three cases: "No. 18" ($5\frac{1}{2}$"x8"x5" deep), "No. 19" (same but with gasketed opening), "No. 22" flush-mounted.

Current-input Controller for Electrically-heated Equipment

This timer (Fig. 4) functions as a temperature controller. It is applicable not only to replacement of rheostat control but in combination with existing automatic control. Four standard models: "Model M" designed to prevent a constant load from rising in temperature beyond desired adjustable setting. "Model MT" exercises the same control of overshooting as Model M but, in addition, is provided with built-in time control which brings input-control into action

after an adjustable period. Models "F" and "FL" are designed for control where loads are variable. Both models adjust automatically to changes in demand, with Model F serving installations having but slight lag in furnace response and Model FL serving where lag is greater.

(1) *Continuous Furnaces:* Where furnace load is *constant*, Model M is wired in series with low pyrometer contact. For *variable* load, Model F or FL, so wired that rate of current

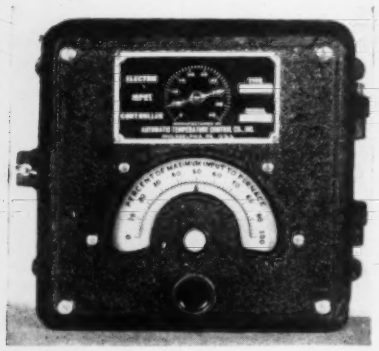


Fig. 4

input is automatically decreased or increased by high and low contacts of actuating pyrometer. (2) *Batch Furnaces:* The input controllers provide improved temperature regulation in the heating-up period, in the soaking stage, or in both, as required. (3) *Program Control for Batch Heating:* The input controller, with ATC standardized time-cam devices, makes possible the control of a complete heating program in which desired heating conditions are governed both as to temperature and time. (4) *Rheostat Replacement for Laboratory Furnace:* This controller affords greater accuracy of setting than obtainable with a rheostat. Controller uses current only in proportion to a given setting.

Emra D. Bacon

Timers, Flashers, etc.

A variety of single-circuit and multi-circuit units is manufactured by this firm. Fig. 1 shows a recent model automatic timer which employs a self-starting and self-oiling electric clock movement; and mercury-to-mercury contacts housed

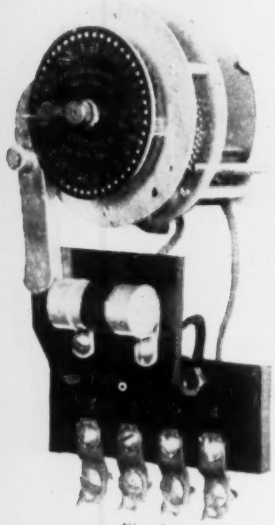


Fig. 1

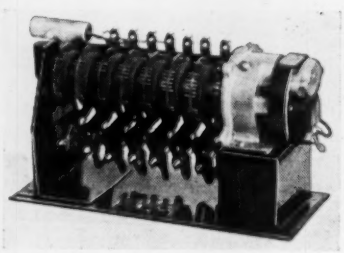


Fig. 2

in unbreakable metal-clad tubes. There is only one moving operating part; and there are no springs. Timing dials in hours, minutes and seconds are available. The timer illustrated in Fig. 2 has seven disks mounted on a square shaft driven by a synchronous motor; each disk carrying from one to ten pins on its periphery, for actuation of mercury-to-mercury contact type switches.

Betts & Betts Corporation

Introductory Statement

"Betts & Betts industrial timers constitute the most c... plete line of time control switches in the world."

I. Industrial Time Switches

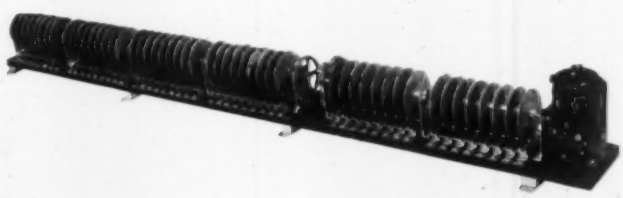
These are synchronous motor driven, twenty-four h... time switches arranged to give any number of short ... pulses during the 24-hour period. These devices are ma... to work in conjunction with the various types of Betts ... Betts Process Timers and Program Controls. They dif... from the conventional type of time switch in that they ca... be set to give a number of impulses spaced at very sho... intervals. *Dimensions:* Round container, 54" diameter, ... deep, suitable for wall or panel mounting.

II. Impulse Timers

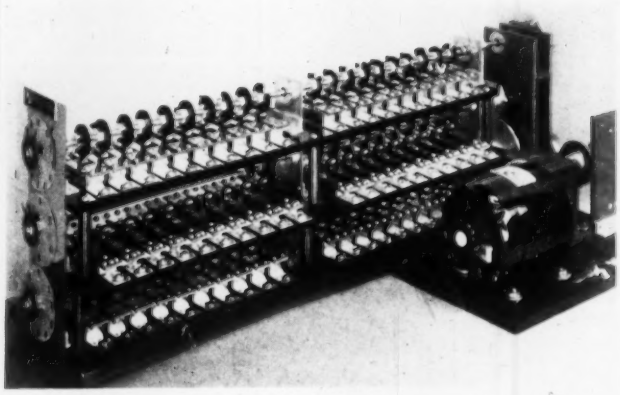
This instrument as the name implies, serves to give per... odical impulses. These impulses either serve to start up equipment that has its own means for stopping or else serves to start up Process Timers. There are three main types of Impulse Timers: (a) Single Impulse Timers made to give impulses at constant predetermined intervals. (b) Selective Interval Impulse Timers provided with means to give impulses at a number of predetermined frequencies. A simple switching arrangement permits the selection of the frequency of impulses. (c) Adjustable Interval Impulse Timers which give a single impulse at an adjustable frequency. All three types of timers may be had for a frequency of impulses ranging from a fraction of a second to 24 hours. *Dimensions:* Round container, $5\frac{1}{2}$" in diameter, 4" deep, suitable for wall or panel mounting.

III. Process Timers

These are multiple-contact timers, accurately adjustable for on and off periods of all circuits as well as for a total cycle of operations. They are made either for continuous



III. Multiple-circuit two-speed process timer.



III. 24-hour process timer with three speeds for accuracy of timing.

repeat operation, or for start and stop action recycling to the zero position. In the latter case, they are usually set in motion by a Betts & Betts Industrial Time Switch or a Betts & Betts Impulse Timer. *Dimensions:* Mounted on panel 6" wide, 6" deep, length is determined by number of circuits.

IV. Code Contactors

These instruments, as the name implies, are designed to give impulses or signals at a predetermined sequence of

...ng and short periods known as a "code". They are remote ...ntrolled or push button operated, and can be set to repeat ...e code once, or several times. These devices range from ...e single circuit types used for alarm signals, or call sys...ms, to the three and four circuit types used to operate ...ngle calls on chimes. *Dimensions:* Round container, 5" in ...iameter, 4" deep, suitable for wall or panel mounting.

V. Reversing Action Timers

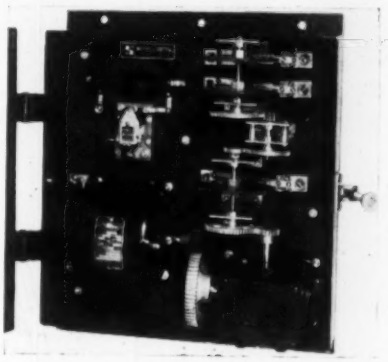
These timers are designed to operate two consecutive cycles of even duration. The timer operates in one direction, stops, and then operates in the reverse direction. The forward stroke is always equal to the backward stroke. These timers can be made to operate constantly back and forth, as is necessary to operate machinery controlled by large reversible motors. Also, they can be made to stop automatically at the end of each forward and backward stroke. In this case, they are set into motion by another timer or remote control device. This type of timer is used to operate valves. The forward stroke of the Betts & Betts Timer opens the valve, the backward stroke closes it. *Dimensions:* Round container, 5" in diameter, 2" deep, suitable for wall or panel mounting.

VI. Motor-operated Time Delay Switches

These are motor driven cam operated switches. They are designed to stop automatically and reset to the zero position and have a very fine degree of adjustability. *Dimensions:* Round container, 5½" in diameter, 3" deep, suitable for wall or panel mounting.

VII. Automatic Signal Control

Remote-controlled, motor-operated device permitting the selection of a number of signal flashes, used in traffic and

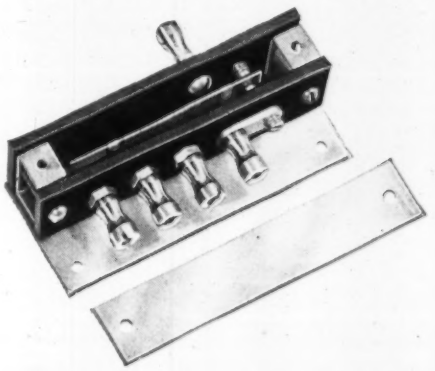


VII.

alarm circuits. *Dimensions:* The size varies according to the purpose; a fairly standard model is one contained in a hinged cover box, 14" × 14" × 7".

VIII. Thermostatic Time Delay Switches

These switches are made to control relays and are designed to delay either the closing or the opening of the relay. They come in two general types: (a) Immediately recycling types; (b) not immediately recycling types.



VIII.

Whereas the most frequently used types have no provision for compensating for ambient temperature changes, special units are made with this compensating feature. *Dimensions:* 3" × 1" × ⅞".

The Bristol Company

[EDITOR'S INTRODUCTION — The Bristol Co. brought out process-cycle controllers in the decade 1920-1930. In the last few years this company has laid stress on "Coördinated Process Control" which is *not an instrument but a system* comprising a plurality of Bristol indicating, recording and automatic-control instruments, frequently engineered to order and customarily under the command of a central program controller made up of standard Bristol parts but specially built and much more elaborate than any of the cycle controllers to which catalog numbers have been assigned. Since this special issue of *Instruments* deals only with time controllers and not with process control in general, descriptions of "Coördinated Process Control Systems" must be omitted and only "regular models" of the maker's cycle controllers, etc., can be included in this survey.]

General Classification

The automatic timers made by this company may be divided broadly into (1) pneumatic and (2) electric.

Within each of these categories there are numerous classes, types and varieties based on number of disks or of cams, number of air lines or electric circuits, initial-impulse methods, reset methods, whether adjustable by steps or continuously, type of motor (and whether single-speed or multiple-speed), etc.

The pneumatic category includes also instruments capable of gradually raising or lowering temperatures, pressures or other controlled variables.

Pneumatic Cycle Controller Pilot Valve

Among the distinctive features of Bristol air-operated time controllers, there may be singled out the "pneumatic relay." Known as Bristol's Patented Three-way Leakless Pilot Valve, this device is believed to have contributed as much, in itself, to pneumatic control as a dozen or so of the recent electromagnetic relays have contributed to electric

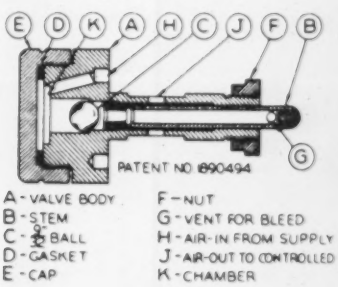


Fig. 1

timers and program controllers. A drawing of one of these valves is shown in Fig. 1. Air at constant pressure (15 to 25 lbs.) is admitted at H and passes into the chamber at K. Raising the stainless steel valve stem B unseats the stainless steel ball C, which permits air to flow along the outside of the stem to the opening J and from there to the valve under control. When the valve stem is lowered and the ball re-seats, the entrapped air vents to the atmosphere by means of an opening down through the center of the valve stem and out at the small opening G. These pilot valves use no more air than is required to operate the valve under control. There is no fixed air leak; the entrapped air between the controller and the diaphragm of the valve under control can be released as fast as desired, since the venting orifice has no relation to the filling orifice of the pilot valve. This item becomes of major importance when considering the application of cycle controllers to a battery of vulcanizers (for example) where the sum of all constant leaks becomes a major item of expense.

A Recent Synchronous-motor-drive Single-cam Air-operated Cycle Controller

"Model 6089V Cycle Controller" is for the control of processes in which the various steps are performed in a given sequence and operate to be stopped in the reverse order. It will control as many as four separate operations. The size and type of case provides for readily accessible parts, for

easy manipulation of the adjustment features. It is equipped with one cam, operating patented leakless three-way pilot valves, from one to four in number, as required by the process. The cam is made adjustable by means of movable segments which may be set to carry out an operation during any desired period, within the range of the controller cam. The pilot valves do not provide throttling action.

A special cam-operating mechanism makes it possible to obtain two speeds of rotation before the cam completes a cycle. With the cam in the starting position, a pushbutton is operated manually to start the controlled cycle. Immediately an electric circuit locks-in a relay so that the pushbutton may be released after momentary contact. The controller cam then starts rotating slowly at constant speed, according to the gear trains with which it is equipped. It

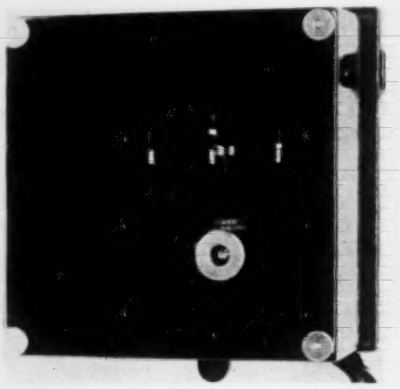


Fig. 2

proceeds at this slow rate, opening and closing pilot valves, as desired, by means of a cam follower, until all of the necessary operations have been performed. When the pilot valves are opened they allow air under pressure at 15 to 30 lbs. to flow to the top of the diaphragm valve being controlled, and in closing they allow the air pressure on the valves to be released. Air cylinders or other pneumatic power devices may also be operated by means of these pilot valves. At the end of the cycle, the cam follower drops to such a position on the cam that all of the pilot valves are allowed to close and the cam rotation is automatically speeded up to approximately 100 times the slow speed of operation. This quickly resets the cam to the starting position for the next cycle of operations. The cam motor thus stops to await the operator's signal for a new cycle.

The two-speed feature involves no gear shifts, governors, springs or escapements. Mechanically simple, it eliminates the difficulties usually occurring from this source in reset cycle controller. At no time does any gear become unmeshed. The motor driving the cam is a synchronous capacitor type, with high starting torque, yet using only 8 watts. It is totally enclosed.

Model A-118 Impulse-Sequence Cycle Controller

This newly-developed cycle controller operates on a slightly different principle. It is offered with one to eight cam-operated pilot valves. Each pilot valve will time the process function and operate that function as many as eleven times. Thus, an 8-cam controller will control the operation of 8 different valves, motors and dampers, pistons or diaphragm operators, switches, or other similar equipment. Each one of these can be operated from 1 to 11 times during a cycle. All of the timing is done on cam disk A.

The controller is flexible in application, being arranged so that additional cams and pilot valves can be added to controllers originally installed with less than 8 cams. Thus, after a 4-cam job has been installed, 4 more can be added with little difficulty later on. Cam shaft C is provided for such additions and the case is drilled for them (D).

The time schedule for a particular set of operations is incorporated into disk A by punching holes around the outer edge of the disk (between the two lines dimly visible just slightly inside the outside edge). When the process starts, this disk begins to turn from zero (the point marked B) at a timed rate. For each operation a hole is punched in the disk at the desired time. As the disk rotates, the hole comes between two jets of air. The cam shaft is moved ahead a small part of one rotation. During this rotation one or all of the pilot valves can be operated depending upon the shape of the cam at this section over which the followers follow.

The timing disk and the cams that operate the pilot valves are independent. This makes it possible to eliminate load from the time disk. It gives accurate timing because it

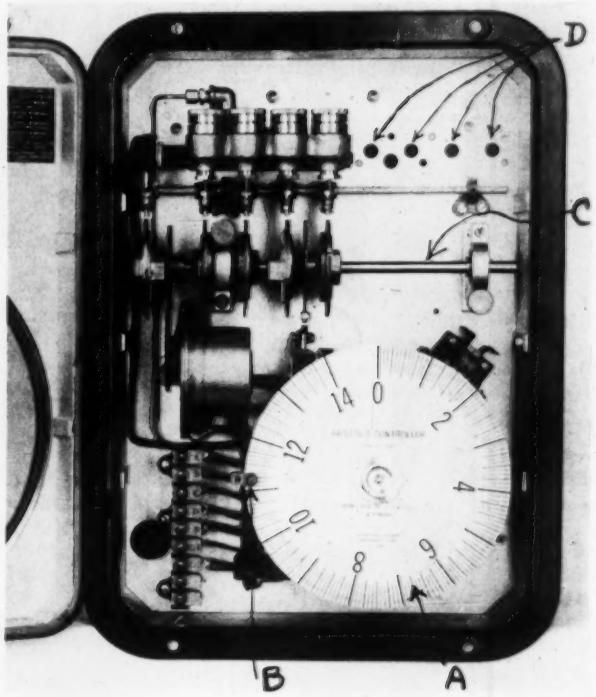


Fig. 3

operates from an accurate clock and because it is free to rotate: it engages no other mechanical apparatus in its travels, but merely passes, as does the free vane of our Free-Vane Controller, between two jets of air.

The timing scale on the 8" disk being about 24" long, accurate timing can thus be obtained. The time schedules can be easily cut into the time disk. This operation merely requires a ticket punch.

Time disks are easily changed and time disks cut for one particular operation can be kept on file for use later in running the same operation.

"Model 6488" Electrically operated Process Cycle Controller

This is a heavy-duty single-cam controller with "Telechron" motor drive. It is equipped with two single-pole (s-t. or d-t.) switches, contacts normally open or normally closed. Change gears provide the speed of rotation (and hence the total time) required. The cam can be cut in such a way as to open and close the switches more than once during one cycle or one cam revolution. This controller is made in three forms:

(1) Performs the operations of one complete cycle, at the end of which it stops automatically and must be started by the operator before the next cycle of operation can be carried out.

(2) After being put into operation runs continuously, performing the operations of one cycle after another with no intermission. Visual indication of elapsed time. Switch capacity 10 amps. at 110 volts a.c.

(3) Intermittent type, equipped with an accurate time scale and a simple manual adjustment for changing the time period of the cycle. No changing of gears is necessary. Accuracy is 0.5% of total scale. Standard scales 0-6, 0-20 and 0-40 minutes (others special). Switch capacity 10 amps at 110 volts a.c.

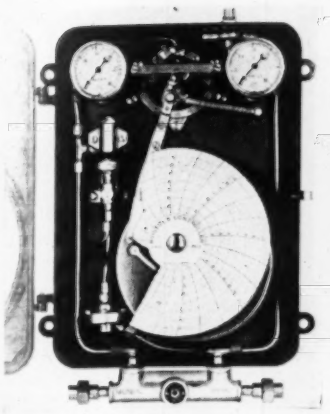


Fig. 4

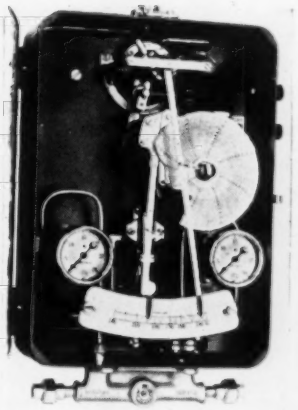


Fig. 5

Temperature-time and Pressure-time Controllers

These instruments resemble round-chart recorder-controllers and utilize chart-like cams, easily cut by the user, which gradually raise or lower the setting of an otherwise ordinary automatic temperature (or pressure, or flow, etc.) controller. Figs. 4 and 5 show two models.

The Brown Instrument Company

I. Cut-cam Type Recorder-controller

The *"Brown Recording Time Cycle Controller"* employs a cam attached to the chart hub (see Fig. 1) to move the setting arm of the temperature controller. The recording

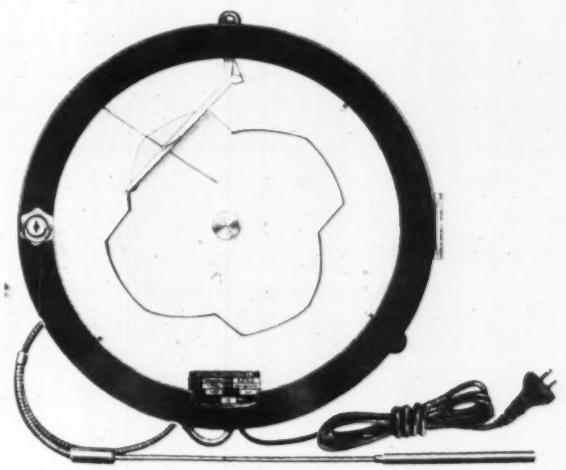


Fig. 1

pen is not obstructed by the cam. Cams may be quickly made on the job by plotting the schedule on a chart for use as a template. The temperature control system is of the electric contact type, with one, two or three contacts. Chart size is 12".

II. Potentiometer with Rate-of-change and Duration Control

The *"Brown Automatic Program Control System"* comprises a potentiometer type controller, usually a single-point indicating or recording pyrometer (Fig. 2) provided with a built-in motor and mechanism whereby the control-point setter is moved upscale or downscale at a constant rate. This rate may be adjusted at will by means of a Rate Controller (Fig. 4). This Rate Controller may be set by adjusting a pointer on a dial calibrated in degrees per hour. In order to stop the control index movement at the desired temperatures, auxiliary mercury switch mechanisms in the main instrument are independently adjustable to the temperature settings desired. Holding a temperature for a desired number of minutes or hours is accomplished by means of the Soaking Time Controller (Fig. 3) which breaks the current to both windings of the control-point drive motor. The control index then remains stationary until one of the drive motor windings is again energized. This time control unit

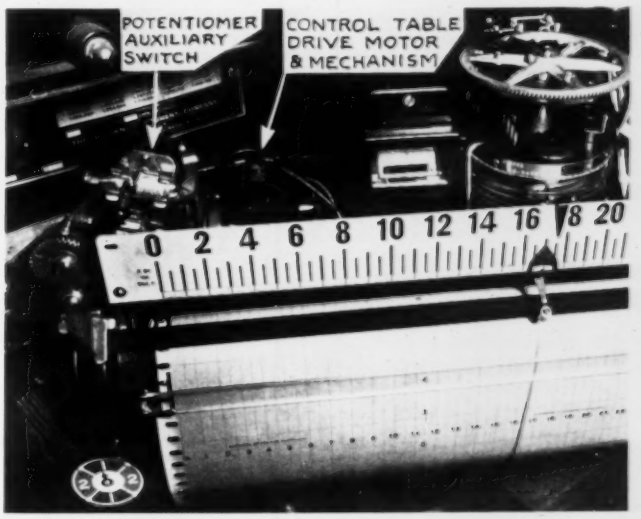


Fig. 2

Fig. 3

Fig. 4

may be set for any period and initiates another Rate Controller automatic operation, or signal, upon completion of the set time.

The system thus provides "any or all of the following functions: 1. Controlled Rates of Temperature Rise or Heating. 2. Controlled Soak-out Temperature. 3. Controlled Soak-out Time. 4. Controlled Rates of Cooling."

C. P. Clare & Co.

[EDITOR'S NOTE—This manufacturer specializes in relays. Since all relays are characterized by time factors, they all are in effect "automatic timers." Only the relatively slow relays—and in particular those relays with *known* time characteristics—are generally classed as automatic timers. Therefore, instead of submitting ordinary catalog data, this manufacturer sent *Instruments* a 44-page technical book which contains general notes and mathematical treatments of relay time constants. From the general notes we have abstracted the following.]

Selection of Coils—Type C Relay

The force developed by the relay armature is proportional to "ampere-turns," the product of turns in the inductive winding and the current through that winding measured in amperes. In many applications it is only necessary that a relay close or open its contacts when its coil circuit is energized or de-energized, with wide limits of

time and power being available. . . . In applications where the operate or release time of a relay must be held within certain limits, coil characteristics are important. Operate time is measured from the closing of the coil circuit until the springs break or make. Release time is measured from the opening of the cooil circuit until the relay springs break or make. The operate or release time of a relay is mainly an electrical lag. This means that the time for the mechanical movement is a small part of the whole. For example, in a certain type C relay it is found that the operate time until the make contacts close is 0.012 sec. Of this time, 0.010 sec. is required by the flux in the magnetic circuit to build up to a point where the armature starts to move. The armature movement is then completed 0.002 sec. later, giving a total operate time of 0.012 sec.... The effect of changing the number of turns on a relay coil is to change its inductance and, in general, increasing the number of turns on a coil increases the inductance; but in relays where the magnetic path is almost entirely in iron the relationship is a complex one becoming a function of the current flowing. . . . The rate of build-up of current depends on the ratio of inductance to resistance. A decrease in this ratio will make the current build-up more rapidly, while an increase in this ratio will make the current build-up less rapidly.

Type D Relay

The delay time in the operation of a type D relay is due to the use of a low-resistance copper ring or "slug" encircling the core on the armature end of the coil. When the coil circuit is closed the flux being built up in the magnetic circuit links the low resistance copper ring. This change in flux through the copper slug results in an emf. and associated current in the slug, which builds up an opposing flux. This opposing flux introduces a time delay in the operation of the relay. Operate times can be varied from 0.01 to 0.1 seconds by proper selection of coils. The release time of type D relays can be held low by the use of heavy spring pressures and large residual settings.

Type E Relay

In the Type E relay the copper slug is placed on the end of the core opposite the armature and near the heel piece. Spring tension is set low as compared to type D and the residual setting is also lower. When the circuit is closed to the relay coil the operation of the relay is not delayed as it is in type D because flux which does not link the copper slug, and therefore, it is not delayed, operates the armature. When the coil circuit is opened the emf. and its associated current in the slug tends to keep the flux in the core and therefore delays the release of the relay. Release times up to 0.5 sec. can be obtained by this means. When release times approaching the maximum are required it is necessary that the magnetic field be strong enough to saturate the magnetic path.

Special Features

Clare Relays may be furnished with any of several special features, each making them adaptable for varying applications:

Double spring insulation, plus wafer insulation between insulators, providing approximately ¼" creepage path between springs.

Ceramic insulation, recommended for frequency circuits.

Heavy-duty bearing assembly—stainless steel shaft operating in self-lubricating insert in hard brass yoke.

Heavy-duty bearing assembly—stainless steel shaft operating in Marine brass yoke.

Anti-vibration springs, often applied on relays to be used in locations where vibration is apt to be great.

Bakelite spring insulating bushing is standard on all Clare Relays.

Micro-adjustment feature may be applied to types C, D, E, F, or A relays, is applicable where difficult timing or current requirements are to be met.

Mechanical Locking Feature which locks armature in the operated position after it has once been operated. Reset is manual.

Controls, Inc.

"Cascade" Principle Timers

"Due to extreme preoccupation with Defense Program work," writes an executive of Controls, Inc., he is unable to prepare detailed descriptions of the automatic timers recently developed by his company. In brief, the instruments are being offered in two types. In each of these types "timer units may be assembled in cascade to cover the desired interval or intervals. In one type we use up to three units to time any desired fraction of 24 hours, adjustably to one-half second. In the other type, designed for process or program timing, any number of hour or minute sections may be assembled in cascade to control succeeding operations, each of which may be timed to one-half second."

R. W. Cramer & Company

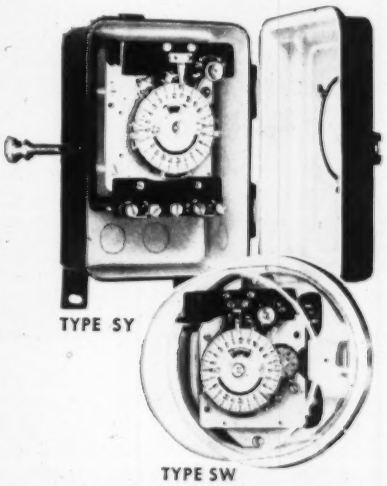
I. Clock Movements

Designed and made solely for automatic time control instrumentation, "Sauter-Cramer" Clock Movements are available in two types: *(1) Synchronous.* Operated by a self-starting slow-speed synchronous motor. Sauter-Cramer synchronous clocks have a vernier setting which permits setting a 24-hour time switch to within 30 seconds. *(2) Electrically-wound Escapement Clocks.* For time switches these have a four-day mainspring. Once or twice a day the spring is automatically wound. A simple patented clutch arrangement causes the winding to cease always at the same point, i.e., the point necessary to compensate for used spring energy. Reserve spring energy keeps clock going three to four days in event of power interruption. Clock proper is precision 13-jewel, lever escapement, Breguet hairspring, Invar balance-wheel, etc.

Various other clock movements, each suited to the requirement, are embodied in small and in special-purpose automatic time controllers.

II. Time Switches

The *sizes* and *types* regularly manufactured and listed in catalogs "meet every conceivable time switch application." Enclosures for indoor, outdoor and underground installation. Oil-break models to 8000 volts and to 600 amperes.



Illustrated are two popular synchronous-motor-drive models available in 4-amp. or 30-amp. capacity for 110- or 220-volt circuits. Each will control almost any type of a-c. circuit operated on a predetermined time basis. Plain or astronomic dials. Vernier time adjustment within one-half minute. The SY model with all-metal housing has a broad field of application; Model SW, designed for mounting in a standard meter socket, is mainly for off-peak and two-rate metering control although it is suited for almost any type of installation where the all-metal type of housing is used.

III. Interval Timers

Designed for use on a-c. circuits to (a) automatically open or close a single circuit at the end of a definite time interval or (b) automatically close one circuit and open

second at the end of a definite time interval. Construction: Essentially a self-starting synchronous motor connected through cut gears and a friction clutch to a cam on which rides a pawl that operates a contact-making switch. The complete mechanism is mounted on a common base and enclosed in a protective housing. Silent operation is obtained by means of a precision-built slow-speed self-starting synchronous motor with enclosed gear train operating in oil. Motor sounds are silenced by means of a fiber gear in the first stage of reduction. Twelve different time scales ranging from a 15-sec. dial with ½ sec scale divisions to a 24-hour dial with 30-min. scale divisions. Switch is a totally-enclosed light-acting quick-make quick-break type with silver contacts rated to carry a ½ h.p. motor load, a 1,000 watt incandescent lamp load or a 1,200 watt heater load, has a life of 1,000,000 operations at rated load and is available with various contact arrangements. *Delayed Start Feature* (optional) permits setting the time pointer without operating the switch unit. Immediately the delayed start feature is operated the switch either opens or closes and the time cycle starts. *Reset Stop* (optional) permits setting the indicator to exactly the same point for each operation, is of great convenience where the same time cycle is to be repeated a number of times. For general purposes, "Model A" is the flush-panel-mounted type and "Model B" is the portable type provided with a 6-ft. rubber cord with plug and two female receptacles. The recent "Model D2" (illustrated) is for control of industrial equipment such as dough mixers, tumbling barrels, heat treating furnaces, laundry machines, etc., in which timers may be subjected to excessive moisture and dust conditions. Timer is enclosed in an especially built cast aluminum housing arranged for conduit connection and provided with a full vision window and external setting knob. Front view bull's eye light signals can be supplied.

IV. Automatic-reset Timers and Variants

These are available in sizes, etc., corresponding to the Interval Timers but differ therefrom in that the switch unit, driven in one direction by the synchronous motor, is reset in the opposite direction by a damped coil spring arrangement. Newest improvement is the micrometer adjustment knob whereby a worm gear moves the setting pointer across the dial at a slow rate. The *"Industrial" Reset Timers* have, in addition, remote-control features. Some models are provided also with an additional pointer, known as Progress Indicator, which travels back toward zero.

V. Time Delay Relays

There are two distinct forms of Cramer devices known as time delay relays: "Type TD," largely similar in appearance and construction to the Automatic-reset Timers, introduce an adjustable or fixed delay between the closing of one circuit and the subsequent closing or opening of another circuit. The other form is the magnetically operated relay in which a clockwork mechanism serves as the timing element. An example is "Type MQ-6" consisting essentially of a Sauter clock-mechanism, a solenoid actuating the clockworks through a linkage, to which the contacts are solidly attached, all mounted on a common base and enclosed in a rectangular metal or Bakelite case. These relays are designed to close a circuit for a preset operating intervals when energized from an external momentary contact device and then to stop, ready to repeat the cycle of operation upon reclosure of the momentary contact device. The contacts are mercury-tube type, rated to carry 6 amperes continuously. The solenoid is designed to provide ample power to operate the clock-actuating spring and the contacts. It momentarily draws 0.4 amp. at 110 volts, hence can be controlled by light-duty instrument contacts.

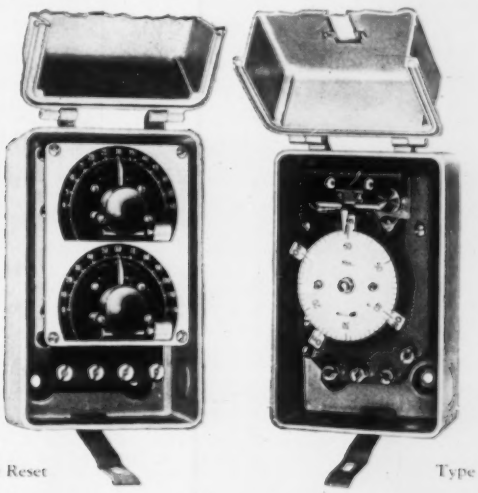
VI. Repeat Cycle Timers

Various forms of these devices are available, some of them essentially similar to the line of 24-hour time switches, others embodying special industrial features. Two examples:

Automatic Double-Reset Timers have been designed for industrial applications requiring an adjustable and rapidly-repeating time cycle. The twin unit consists of two Reset Timer mechanisms mounted upon a control panel and controlling common electrical circuits. Both have the same adjustments and "band-spread" time scales.

Operation may be described by a typical use: furnishing a 10-second impulse every 90 seconds for signalling or heating control purposes. For this, a 120- and a 15-second timer are combined; one timer is set to close the control circuit in 90 seconds; the other is set for 10 seconds. Switching arrangement of the entire instrument can be used as a s-p. d-t. switch. Once the unit has been energized, first timer closes control circuit at end of 90 seconds; second timer then operates simultaneously with delivery of desired impulse for a period of 10 seconds. First timer has meanwhile reset and is again put into operation at end of the 10-second interval when second timer opens control circuit and cuts off the impulse. The 90-second interval then recurs. This continues until external control switch is opened.

Double-Reset Timers are furnished for 110- or 220-volt and 50- or 60-cycle operation. Time ranges available for each of the individual timers are 15, 30, 60 and 120 seconds, maximum. Current carrying capacity of the switches is 10 amperes at 110 volts 60 cycles. Housing dimensions are $7\frac{5}{8}$" × $4\frac{3}{4}$" × $3\frac{3}{4}$".



Double Reset — Type C.T.

Type C.T. Cycle Timer has been designed for use on a-c. circuits to (1) continuously close and open a single circuit at any pre-set operating interval, or (2) alternately close and open two circuits at any pre-set operating interval, one circuit opening instantaneously with the closing of the other and vice versa. It has eight time scales ranging from one rev. in 60 seconds to one rev. in 24 hours. Each dial is equipped with four operating arms, 2 "on" and 2 "off" so that either one or two cycles of operation can be obtained in one revolution of the dial. Either cycle of operation can be independently timed in respect to the other. Operating arms are adjusted by loosening a knurled hand screw and sliding operating arm to desired time setting. Timing motor will start on ±20% of rated voltage.

VII. Program Clocks

These were originally designed for schools, etc., but find an ever-increasing number of industrial applications. Their most familiar feature is the large 5-minute dial which permits a one-second accuracy of timing for each of the operations (up to 30) during the customary 24-hour cycle.

Struthers Dunn Inc.

Classification by Operation

"Dunco" Timing Devices may be divided into three groups depending on their operation: (1) Immediate recycling; (2) Not immediate recycling; (3) Repeating. An "immediate recycling" timer, as soon as it has completed a cycle is ready to start a new one when power is removed and again applied. The meaning of "not immediate recycling" is obvious. By "repeating" is meant a timer which repeats its cycle over and over when power is applied.

Operating Characteristics of Principal Types

Thermal (*Hot Wire* and *Bimetal*) timers are inherently not immediate recycling as they must be allowed to cool after they are heated. By using one or more relays in conjunction with the thermal unit and making use of both the heating and cooling time, they may be made immediate recycling. The use of two immediate recycling timers and a load relay will make a repeating timer. It is usually less expensive to use a motor-operated timer when a repeating timer is required.

Motor-operated timers are repeating unless provisions are made to stop the motor. When this is done, the use of auxiliary relays or a spring return will make them immediate recycling.

Capacitor timers may be used only on d.c. and only for delayed dropout. They are practically immediate recycling, the only time required being the time to charge the condenser. On low voltages or for long times, the cost of the condenser may eliminate this type.

Inertia timers may be of many different types, some of which are practically immediate recycling and others which require as much time in one direction of travel as in the other. The time delay obtainable with this type of relay is short so that the recycling time is usually not much of a factor.

(*Electronic* timers constitute a class by themselves. One is described at the end of this article.)

The following table shows the timing for which the various types may be used:

Time Interval	*Type of Timer*	*Recycling*	*Voltage*
0.01 to 0.1 sec.	Capacitor	Immediate	6-220 d.c. only
0.04 to 0.2 sec.	Inertia	Immediate	6-220 a.c. or d.c.
0.2 to 2.5 sec.	Air Dashpot	Immediate	6-220 a.c. or d.c.
3 to 13 sec.	Hot Wire	Immediate	6-18 a.c. or d.c.*
15 sec. to 5 min.	Bimetal	Immediate	6-220 a.c. or d.c.
15 sec. up	Motor-driven	Immediate	110/60 cycles only**
1.5 to 6 sec.	Hot Wire	Not immediate	6-18 a.c. or d.c.*
15 sec. to 2 min.	Bimetal	Not immediate	6-220 a.c. or d.c.
15 sec. up	Motor-driven	Repeating	110/60 cycles only**

* Thermal (Hot Wire) timers may be used on higher voltages if a transformer or resistor is furnished.

** Motor-driven timers may be used on other a-c. voltages and frequencies if a transformer or resistor is furnished. Motor-driven timers are also available for d.c., but are more expensive and not so reliable or dependable as for a.c.

Adjustability

Motor-operated timers (like the TD83) are adjustable over a range of 20 to 1 (maximum to minimum). Adjustable cams may be furnished on the repeating type (like the TD130) making them adjustable from zero time to half the revolution time of the camshaft or from half the rev. time to the full rev. time.

Thermal timers may be adjusted from approx. 50% below the average timing to approx. 50% above the average timing (a range of roughly 3 to 1).

Capacitor type timers are not readily adjustable although some adjustment may be made by means of the tension spring or the use of a variable resistor in the discharge circuit.

Some types of *inertia* timers are easily adjustable over a range of approximately 5 to 1. Other types are not readily adjustable.

Accuracy

Motor-driven timers, due to their use of synchronous motors, are extremely accurate. They are not affected by voltage changes of ±15%. The immediate recycling types have a small error which enters on starting. This is a constant error and although small it may become a factor if the minimum time setting is extremely short.

Thermal timers are compensated for changes in ambient temperature and have an accuracy of approx. ±10%, depending on constant current supply.

Capacitor timers have a high degree of accuracy if the supply voltage is constant and the condenser is allowed time to become fully charged.

Inertia type timers are highly accurate if the voltage remains constant.

Motor-driven Time Delay Relays

Type TD Repeating Timer consists of a synchronous motor driving a cam which opens and closes a set of single-pole single-break contacts at regular intervals as long as the motor circuit is energized. The *TD130* (Fig. 1) is geared to make contact once every minute (duration of closure time adjustable 0-30 seconds), but with the proper gearing practically any time interval may be obtained. This timer does not return to starting position when the motor circuit is broken.

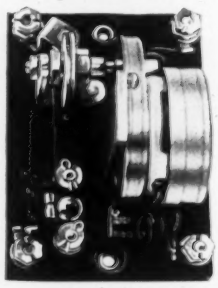


Fig. 1

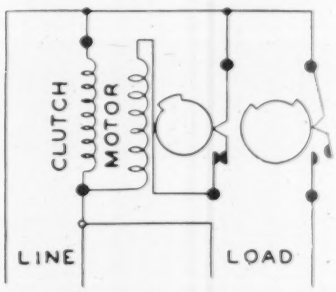


Fig. 2

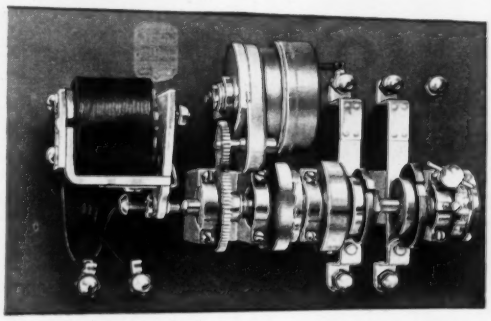


Fig. 3

Fig. 4

The *TD325 Timer* (Figs. 2 and 3) consists principally of a small synchronous motor which drives cams through a series of gears. The motor starts as soon as the circuit is closed. A small magnet operates to mesh the gears at the instant the motor starts. When the time interval is completed and the timed circuit closed the motor is de-energized through a contact on one cam, the magnet remaining energized, keeping the timed circuit closed until the control circuit is opened. The relay is now ready to start a new cycle. Timing adjustment by graduated scale, range 5-100 seconds. Other ranges available. Base $8\frac{3}{4}$" × $5\frac{1}{2}$".

Hot Wire Time Delay Relays

To obtain temperature compensation a *bow type* timer is used instead of bimetal. A slow change of ambient temperature will affect both members alike and have no effect on the time interval, but when quick application of heat is made to the thinner metal which acts as a string to the bow, it releases its tension and permits the bow to "walk" over and make contact.

Fig. 4 shows the *Type TD97 Relay*. Its delay is 5 seconds minimum, 2 minutes maximum. Immediate recycling. Dimensions—5" × 4" × $1\frac{3}{4}$" deep. Coil—110 volts, 60 cycles. Contacts—110 volts a.c., 6 amperes.

ectronic Timers

These devices do not introduce one delay but usually pro- e a *predetermined sequence of impulses.* The Type TD240 ectronic Timer is an electronically operated automatic closing device. The number of impulses per cycle and the tal time of the cycle are independently adjustable. Vari- s total times are available, depending on the choice of rcuit constants and the types of vacuum tubes employed. *peration:* The closing of an external contact (which may due to an overload, an underload, etc.) energizes the coil f a relay whose contacts open the interlock or power cir- uit of the equipment being controlled. Other contacts on he relay lock it in electrically and energize the filaments f a pair of vacuum tubes. One of these tubes controls the umber of impulses and the other controls the total time f the cycle. When the filament of the impulse tube has eached sufficient temperature, it energizes the coil of the impulse relay. This relay picks up, causing the load relay to drop out, and then drops out. If the external contact remains closed, the load relay picks up again and the impulse and load relays go through one cycle after another until the external contact opens or the filament of the second vacuum tube reaches sufficient temperature to energize the coil of the lockout relay. When the lockout relay picks up, it locks in electrically and the equipment must then be reset, manually, before it will go through another cycle. In case the control contact is only closed momentarily, the load and impulse relays will only go through one cycle and will then restore conditions to normal. If spare equipment is available, the lockout relay may be used to energize it, thus minimizing the time the equipment is out of service. Timing available 2 to 9 seconds for the total cycle. Number of impulses 1 to 15 (the number of impulses and total time are interdependent. In other words, 15 impulses require longer than the minimum time of 2 seconds, taking about 4 seconds). The first impulse may be delayed until near the total cycle time, the succeeding impulses follow as approximately $\frac{1}{4}$ second intervals.

Eagle Signal Corporation

General

Most types of timing devices for industrial applications come under one of two general classifications: (1) *Reset Timers* that go through a cycle of operation then stop or reset to starting position. These can be adjusted to either reset or not reset in case of power failure. (2) *Repeating Cycle Timers* that repeat the cycle of operation over and over again as long as power is applied. These will not reset in case of power failure but will resume timing the unfinished portion of the cycle when power is restored.

Both types usually embody synchronous motors for the driving element and are, therefore, efficient and accurate in timing. Reset timers, because of their high degree of flexibility and simplicity of control, are most commonly used in processing applications. An idea concerning the possibility of such control devices will be obtained from the timing specifications covering models of reset timers.

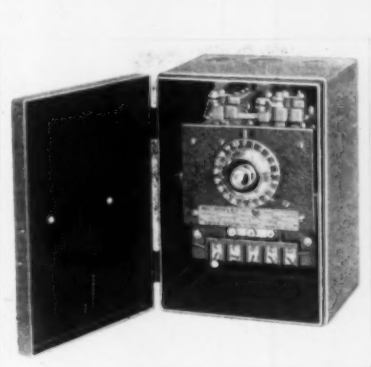
Model	*Adjustable Timing*	*Adjustable Range*
1	1/30 sec. to 20 sec.	±1/60 sec.
2	0.2 sec. to 120 sec.	±1/10 sec.
3	2 sec. to 20 min.	±1 sec.
4	2 min. to 20 hours	±1 min.
5	10 min. to 100 hours	±5 min.

The "Microflex"

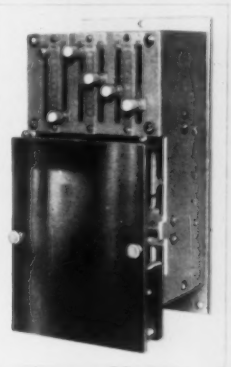
This instantaneous-reset timer is distinguished by an unusually wide range of adjustment: 600 to 1. Its name is derived from the micrometric vernier or compound dial, which makes possible the accuracy guarantees listed in the above table. These units are incorporated in some elaborate process controllers featured by well-known instrument companies.

The "Multiflex"

This timer is designed for applications requiring one or more contact operations in a timed sequence. Timers for controlling from one to six circuits may be supplied in a single unit with the opening and closing of each circuit independently adjustable. Unit consists of a moving plate driven by a synchronous timing motor through a solenoid-operated clutch. Contacts are closed and opened with a quick make and break action as this plate is driven downward. When clutch is disengaged, plate is reset by a spring. Less than $\frac{1}{2}$ sec. is required for resetting from longest possible cycle for which timer can be set. Several control



"Microflex"

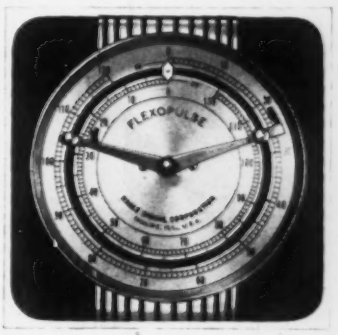


"Multiflex"

circuits for the clutch coil are available. Each circuit contact has "on" and "off" indicators which are independently adjustable along a linear time scale by loosening a thumbscrew. Vernier adjustments (not illustrated) can be provided where extremely accurate time adjustments are required. These consist of adjusting knobs located above the time scale for each contact. One complete turn of knob advances indicator one division on the linear scale.

The "Flexopulse"

This is a repeating cycle timer which utilizes reversing action without reversal of motor to provide an extreme range of contact in a continuously repeating series of opera-



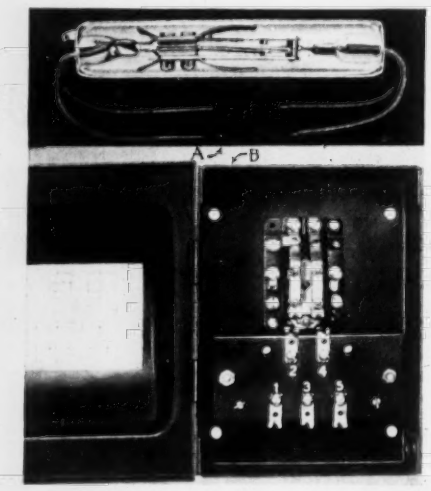
tions. The cycle and percentage of contact closure time may be adjusted without changing gears or adjusting cams. Three models are available, providing ranges of 2—120 sec., 20 sec.—20 min., and 2—120 min. .Models may have s.p.s.t. or s.p.d.t. switch. All models have $5\frac{3}{4}$" diam. clock face dials: one adjustment arm regulates length of closure, the other regulates length of opening.

Thomas A. Edison, Inc., Instrument Division

Thermal Relays

Edison Sealed Thermal Relays are s.p.s.t. switches (up to 240 volts) operated by a second (relatively small) current. Type KW is molded in plastic; all others are hermetically sealed in an arc-quenching inert gas. They work equally well and have equal capacity on either a.c. or d.c. (except type KW, where the load circuit is for a.c. only). They are not affected by dust, water, etc., and in general may be used in explosive atmospheres. Some are not affected by changes in surrounding temperatures. Others automatically lengthen the timing as ambient conditions grow colder, and shorten the timing with the frequency of operation. They range in

size from 9/16" to 1" diam. and from $2^1/_2$" to 5" length. They are absolutely silent. Each is made up especially to fit its individual job. *Timing* may be had for any period between a second and a half hour, and most timing may be varied during operations. They are available unmounted or in a variety of mountings suitable for radio tube base, fuse clip, or panel board use. Unmounted relays are regularly manufactured with bare or spaghetti-covered copper leads, $2^1/_2$" to $3^1/_2$" long.



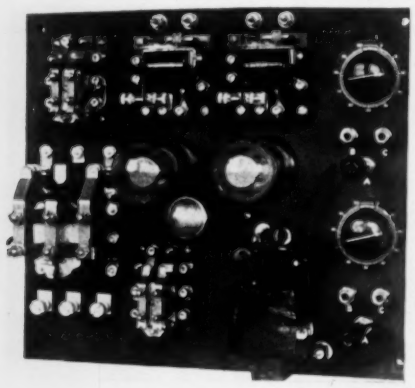
Timing Relay Series 107000

This assembly has been designed for application where a timing interval between the functioning of two or more circuits is required. The 15-sec. time interval is provided by the sealed thermal relay which actuates an auxiliary magnetic contactor. When the control circuit is closed, the heater coil of the Edison Relay is energized. After 15 seconds, the main contacts of the relay close the magnetic contactor circuit which controls the direct load circuit.

The Electric Controller & Mfg. Co.

Repeat-cycle Timers

The capacitor charge and discharge principle is utilized in this company's Automatic Repeat Process Timers. Both "on" and "off" periods are independently adjustable; each



can be adjusted from 0.05 sec. minimum to 0.9 sec. maximum on the smallest size of timer. With both periods set at minimum, this timer will provide 550 operations per minute. With the largest size, the periods are adjustable between 0.12 and 7.5 seconds. Available timers are designed for operation on 110-, 220-, 440- or 550-volt circuits on any standard frequency.

Special Timers for Welding

This company has developed a number of types and models of electronic timers for the various classes of welding work.

Electric Switch Corporation

Staley Time Cycle Controllers

These controllers are assembled from standard interchangeable parts so that it is possible for us to build a controller to fit most any need. The use of Staley Metallic Mercury Switches assures dependable timing that does not change because of wear.

There is a choice of five types of motors: (1) standard shaded-pole, (2) special shaded-pole, (3) synchronous, (4) universal, (5) reversing. In addition to standard listed reduction gears, other sets are available giving camshaft speeds from 2 r.p.m. to 1 rev. in 24 hrs.

Staley Metallic Mercury Switches are available in 5-, 10- and 15-amp. capacities and in various types.

Controller models may be had with various single-point and multiple-point cams, rocker-arm assemblies, brakes, clutches, terminal panels, etc., in addition to choice of motor.

Standard Controllers (A) comprise standard parts that will mount on a standard base without alterations.

Standard Controllers (B) are made from standard parts that require a longer base and case; but all parts are interchangeable.

Special Controllers (C) are of special designs involving alterations in mounting of transformers, fuses, etc., inside the case, or the use of tandem shafts and other modifications.

"Model 602" Time Cycle Controller

This is the most widely used model because of its great flexibility. It incorporates such features as large adjustable cams for close timing; adjustable and interchangeable mo-

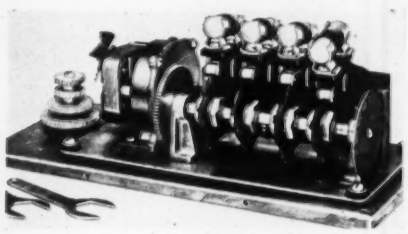


Fig. 1

tor mounts; interchangeable gears which give various camshaft speeds; s-p.s-t., d-p.s-t. and s-p.d-t. arrangement of mercury switches; timing dial for accurate timing; and the added feature of removable camshaft. This is particularly desirable on certain types of production machines where various programs are desired: different programs may be set on separate shafts and the operation of the machine changed by removing one shaft complete with cams and replacing it with another.

"Model 635" Multiple Recycling Controller

This controller (Fig. 2) utilizes two different speed motors driving the camshaft through overriding clutches to

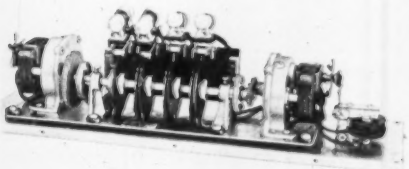


Fig. 2

obtain quick recycling, long time delay or adjustable increments of time on certain operation, which do not affect the time of other operations.

"Model 648" (Motorless)

This is a drum type controller designed to be either (1) positively-driven in exact synchronism with a machine, or (2) rotated intermittently or variably in accordance with process conditions.

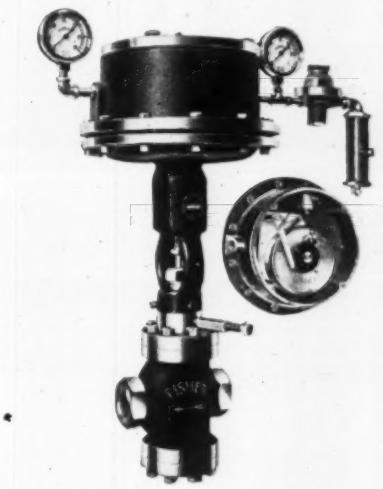
Special Controllers

Controllers using non-standard parts are made up to fit requirements of space, position, etc.

Fisher Governor Company

Pressure-time Cycle Controller

This is a repeat-cycle pressure controller, in the form of an assembly combining a diaphragm-motor valve with a complete air-operated, clock-driven cam-and-rider type of automatic sequencing instrument such as is usually installed on a panel board. Compressed air at 20 lbs. is employed to



operate the diaphragm-motor valve, so that when high-pressure air or gas is the controlled medium, no separate compressor is required, the valve-operating medium at 20 lbs. being obtained through a reducer from the high-pressure line itself. Standard 24-hour clocks provide 1-, 6- or 24-hour cam rotation periods. Cam blanks are circular plates of rustless metal, on which notches are readily cut and filed in the field. Principal applications reported are on gas-lift in the oil fields (for which controller was especially developed).

The Foxboro Company

Classifications

For the control of related or coördinated steps which, in their proper succession, constitute a definite process cycle, Foxboro presents simplified and flexible systems for Automatic Process Operation, available for either

(S) Sequence cycle or *(T) Time cycle*

control (as briefly described below) or for *combinations* of these two types of systems. The instruments employed are standard Foxboro instruments. The "master" instruments may be classed as

(M) Multiple-cam or *(C) Chart-cam*

timers, which are different in form but perform somewhat similar timing functions. Again, the standard Foxboro control instruments employed may be either

(E) Electrically-operated or *(A) Air-operated*

or a combination of both classes. At first glance, it would seem that most systems would generally follow the vertical division of the above, thus: S-M-E or T-C-A. However, this is not a rule: the majority of Foxboro automatic process operation systems in use do not fit into either of these two simple categories. The reason is that each system is definitely engineered for each individual application — a process in which a mere time program (like that of a sign-flasher, for example) is subordinated to the control of *processing conditions* such as temperature, pressure, etc.

In *Sequence Cycle* systems, each successive step in the process cycle automatically follows as soon as (and not until) the desired condition (temperature, pressure, volume or other variable) of the preceding step is obtained, instead of at the expiration of a definite and fixed time period.

In *Time Cycle systems*, successive steps of operation and control are automatically and precisely duplicated with each repetition of the process cycle. The time periods of the individual steps may vary from seconds to hours, and during each of these periods any kind of process operation can be provided. Many applications of Foxboro Automatic Process Operation combine *both* time and sequence operation.

In addition to the main classifications given above, there is of course a choice of timing drives: synchronous motor, spring-wound clock, etc. The system may also include signaling equipment, as well as safety shut-down, automatic recyling or alarm signals in case of power failure. Recording (at any desired place or places) may be provided by means of pneumatic or electric transmission systems; and so may centralized supervision from any desired point.

Multiple-cam Timers

Foxboro multiple-cam timers are highly-developed forms of the camshaft type of instrument. Extreme flexibility has been striven for in their design. For example, the instrument shown in Fig. 1 can be supplied for all-pneumatic operations, or combination pneumatic and electric. The elec-

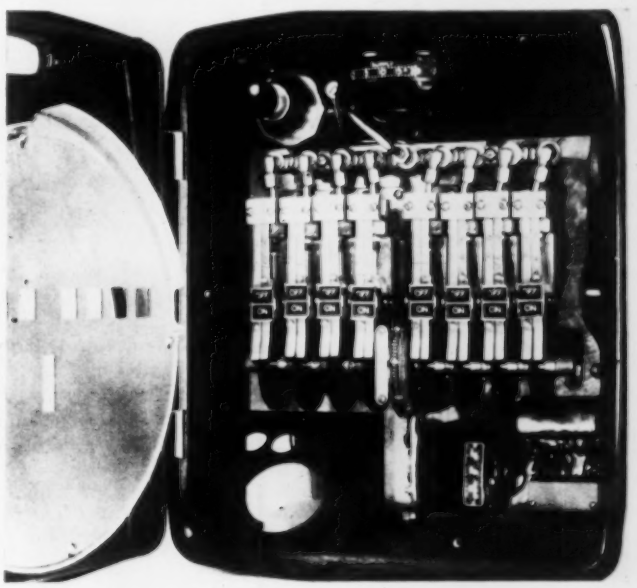


Fig. 1

tric contact assemblies are interchangeable with the pneumatic units. The cam design includes a micrometer setting of adjacent cams. An explosion-proof motor, in Crouse-Hinds housing, is supplied for hazardous locations. Any number of cams can be provided, in sets of eight, with the several cases arranged for through drive from a single motor. In each instrument, all of the individual-function cams are independently adjustable. Although any single cam in this type of master instrument does not provide gradual rise or gradual decrease of a controlled variable, the equivalent may be accomplished by "step" control of properly-selected Foxboro valves.

Chart-cam Timers

This other type of Foxboro "master" instrument was first brought out ten years ago (*Instruments*, October 1931, page 574) as a single-cam instrument featuring a chart-like

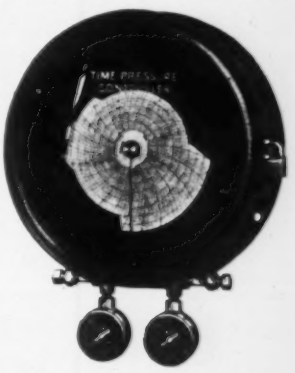


Fig. 2

aluminum cam easily cut by the user. This original cut-cam time controller was primarily a pressure controller or a temperature controller with its setting arm arranged as a cam-follower. This combination type is still available but

the cut-cam type more generally used as a master process timer is purely a time controller which has under its command a pressure or temperature controller or a plurality of such controllers, as well as signals, etc., and may have as many as three cams. Fig. 3 shows the two cams of a master process timer for automatizing a process which requires

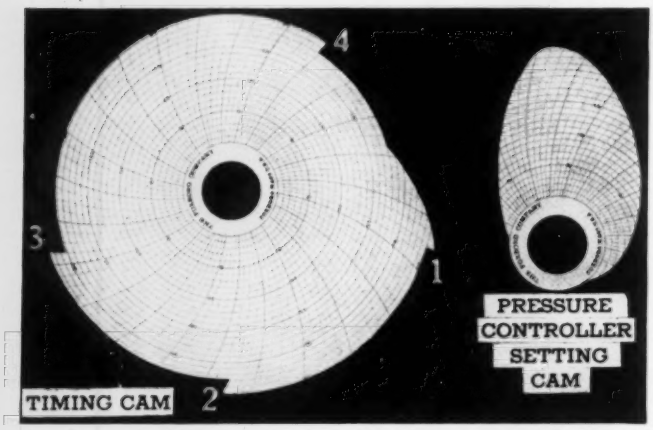


Fig. 3

venting and purging, pressuring and depressuring, signaling, etc. At the left is the timing cam which operates various solenoid and motorized valves. At the right is shown the gradual pressuring and depressuring cam mounted on the same shaft with the timing cam. Its cam-follower is directly linked to the control-point setting mechanism of a Pressure Stabilog Controller (or whatever the instrument may be). Chart-cam timers find applications in industries where one array of equipment is used for the processing of a series of different products, each requiring a special schedule: a cam assembly is cut for each product and plainly marked. When it is necessary to change schedules, the supervisor need only give the operator the proper cam assembly for the product, and he is sure the schedule will be correct.

Julien P. Friez & Sons (Div. of Bendix Aviation Corp.)

Combination Electric Clock and Time Switch

The "Nite-Temp" is a synchronous, self-starting electric clock switch especially suited for day-night temperature control applications. It may be located near the temperature control instrument or in remote location—wherever a handsome electric clock would be of use as a time-keeper. Clock motors operate on 20 volts from transformers supplied with the clocks, which are in turn supplied from the 110-volt or 220-volt lines according to specifications.

General Electric Company

[EDITOR'S NOTE—From a mass of printed and mimeographed G-E material we have selected six individual items representing products made for industry rather than for domestic-appliance dealers, etc. These are: three "timers," two adjustable time-delay "relays" and one "time switch."]

"TSA-10" Timer

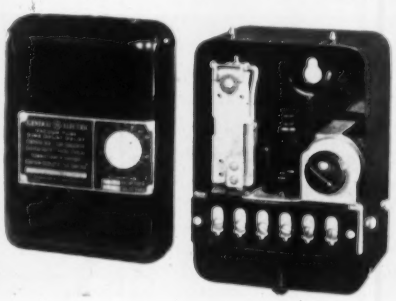
This is a Telechron-motor-timed adjustable type, for use on a-c. circuits only and is available in time ranges from 0-5 seconds to 0-6 hours, with internal or external time-set knob, with or without clutch-coil contacts, with normally-open or normally-closed contacts, with single- or double-time-scales, etc., so that a total of 592 forms are assigned catalog numbers. The adjustment range on each form is 0-100% of maximum time and the accuracy is 1% of the full time of the scale in use (whence the advantage of double time-scale forms). The "TSA-10" is regularly a non-repeat timer but is optionally furnished with an additional contact at zero whereby repeating operation is obtained from a single instrument. Elapsed time is visually indicated. *Dimensions:* 9" high, 6⅛" wide, 4" deep. Surface mounting only.

"TSA-14" Timer

This is a continuously-repeating type. The total time of the cycle (seconds or minutes) is set during manufacture and the adjusting dial, marked "Percent of Total Time," permits varying the "on" time from 1% to 99% of the cycle time. Contact rating is 10 amps.; circuit arrangement is s-p. d-t. Setting is internal only and the glass cover can be sealed by a standard seal wire. *Two-circuit forms* of this timer are available, in which one Telechron motor and one gear train drive a cam shaft but there are two cams and two contact assemblies. Elapsed time is visually indicated. *Dimensions* of single circuit form: 5" diameter, 3⅛" deep. Conduit mounting. Wiring connection: leads.

"CR-7504" Timer

This is a general-purpose capacitor-discharge-timed interval, non-repeat, adjustable type, referred to in G-E literature as a "timer" and also as a "vacuum-tube time-delay relay." Presumably, the time range determines the designation: the two-minute "CR-7504-A1C" would be considered a timer while the "A1E" form whose range is 0.045 second to 0.9 second would be considered a time-delay relay. In all forms, the adjustment is stepless and is effected by an



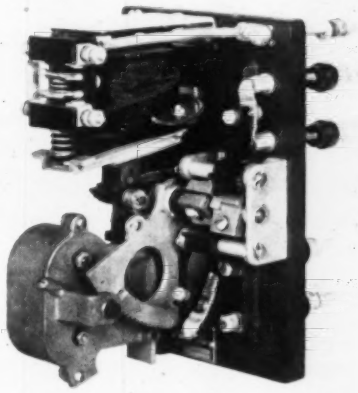
external knob; and the time scale is closely "logarithmic" with open graduations at the short-interval end and relatively close graduations at the long-interval end. The adjustment range is from 5% to 100% of the maximum time. There is no visual indication of the elapsed time and, for that matter, there are no moving parts except for the telephone-type relay. The standard relay contact rating is 1 amp. at 115 volts; 0.5 amp. at 230 volts; higher ratings (to 10 amps.) being listed as specials. The vacuum tube is a 6C5 three-element high-vacuum metal tube which can be replaced through any radio supply store. This timer is available also for d-c. operation. In all models the standard circuit arrangement is s-p. d-t. *Dimensions:* 7 1/16" high, 4⅞" wide, 4½" deep.

"CR-2820-1099" Relay

This is a Telechron-motor-timed interval, non-repeat, adjustable type, operating on a.c. (d-c. optional). It is available in forms providing timing from four seconds to two hours, but it is designated a "relay" and not a "timer." Presumably, the reason is that all forms have the instantaneous-reset characteristic, whereas most "timers" of the non-repeat class require an appreciable time for resetting. The adjustment range on each form of this relay is from approximately 10% to 100% of the maximum time. Adjustment is in steps of approx. 5% of maximum time. Scales are marked in time units. Setting is internal. The contact rating is 15 amps. *Dimensions:* 5" high, 6½" wide, 6" deep.

R-2820-1054" Relay (also "-1088 and "-1729")

This is a magnetic flux-decay interval type; instantaneous pickup and time-delay dropout; instantaneous reset. The forms available provide timings from 0.25 second to seconds. (Note: "CR-2820-1088" available with total times from two to seven seconds; longer times special.)



The adjustment range on each form is approx. 50% to 100% of maximum time. The setting being by spring-tension adjustment, it is internal and stepless, but there is *no* graduated time scale. These magnetic flux-decay devices (in common with capacitor-discharge types) have no elapsed-time indication. They operate on d.c. (also on a.c. with rectifier), the maximum voltage being 600. Voltage fluctuations do not cause timing errors. Contact rating is 5 amps. d-c. continuous. Up to four circuits can be controlled by the available circuit arrangements. Thus, one relay can time *a sequence of several operations.*

"Type T-44" Time Switches

Although there are special industrial G-E time switches (24-hour class) it seems best to conclude this brief survey with only the "Type T-44" which are designated as "general-purpose" time switches. "Type T-44" time switches

open and close electric circuits at predetermined times on a daily repeating cycle. They are furnished in a variety of switching forms and are for use either outdoors or indoors. The switching forms include s-p. s-t., d-p. s-t., s-p. d-t., d-p. d-t., also a form which controls two circuits with one time switch. Some forms (known as "plain dial" switches) open and close circuits at the same time daily, unless the setting is changed by the user. They are equipped with a 24-hour dial and adjustable switch-tripping riders. The riders are set on the dial at the times at which operations are desired. Other forms are equipped with an *astronomic dial.* These forms open and close circuits according to schedules which vary daily.

All "Type T-44" time switches may be equipped with omitting devices. The omitting device automatically omits operations on any day or days of the week.

The time switches are rated for 115 volts or for 230 volts, a.c. Other voltage ratings are available on request. The contact current rating is 35 amp. a.c. for Mazda inductive or resistance loads.

Each time switch has four main units: (1) "Telechron" synchronous motor for time keeping and driving torque. (2) Gear train and time-setting device. (3) Dial with riders which may be set to the desired operating time. (4) Switch mechanism.

Power is transmitted from the Telechron motor to the time dial by a gear train which includes a ratchet and time-setting knob. At the top of the switch is a small dial marked in minutes so that the time may be set or read to the nearest half minute. The ratchet provides a positive drive from the Telechron motor to the switching mechanism. No friction clutches are used.

The dial driven by this gear train turns once in twenty-four hours. Riders on the outer edge of this dial operate the switch. On the forms equipped with plain dial, the riders are clamped directly on the dial at the times of day which correspond to the selected switching schedule. On the astronomic-dial time switches the riders are clamped to arms which are automatically moved in accordance with a definite yearly schedule. Standard schedules are based on the variation in the length of days during the year. Switches having standard schedules will turn lights on at dusk and off at dawn (not sunrise-sunset).

The riders on either the plain or astronomic-dial time switches engage the two triggers of the switching mechanism alternately. These triggers release each other alternately and rock a Textolite cam. A pair of contacts has one rigid blade and one spring blade. Both of these are fastened directly to time switch terminals which are molded in the Textolite terminal block.

Dimensions: 7½" high, 4¾" wide, 4¼" deep. The "Type T-44S" time switch fits standard meter sockets. The sockets are wired and the time switches are then plugged into the socket. The combination may be sealed with any standard type of meter seal.

Guardian Electric Manufacturing Co.

General

Manufacturers of an extensive line of a-c. and d-c. relays. Only two models are explicitly designated as "time delay relays" but this appears to be a matter of catalog terminology. Five distinct means of introducing time delays are manufactured, any of which may be embodied in a relay officially designated as "power type," "solenoid," "sensitive d-c.," "midget a-c.," etc., etc. The five methods are as follows:

Copper Slug

For d.c. only. *Principle*—Copper slug requires time for saturation or de-energizing. Copper heel for delayed release, copper head for delayed attract. Time Delay range—attract, up to 0.05 sec.; release, up to 0.15 sec. Instantaneous recycling.

Thermal Strip

For a.c. or d.c.—*Principle*—Bimetal strip has contact in movable end. Strip is wrapped with insulating material and wound with Nichrome wire. Energizing the wire winding causes heat, bending the bimetal strip and opening or closing the contact after a delay period. Contacts for either delayed make or break on the energizing cycle. Time Delay Range—5 to 80 sec. Bimetal requires approximately three times the delay interval to recycle. Used in conjunction with standard relays (Series T-100 and T-110) for delayed attract or release action on impulse circuits.

Dashpot

For a.c. or d.c. *Principle*—Plunger of solenoid is closely fitted to the brass tube. Leakage of air through screw ad-

justed valve in end of tube regulates time delay period. Delayed release only. Time Delay range to 0.75 sec. Instantaneous recycling. Coils for intermittent duty only.

Hot Wire

For a.c. or d.c. *Principle*—A Nichrome wire is held under tension. When current passes through wire, the wire stretches and, through a lever, operates contacts. Either delayed make or break. Time Delay Range—0.2 to 1 sec. Recycling time approx. same as the energizing cycle. For low voltage (6 to 10 volts) or series circuits of 0.5 to 2 amps. only.

Capacitor

For d.c. only. *Principle*—Capacitor is connected in parallel with a relay coil. When energized, the capacitor charges and the relay attracts. When de-energized, the capacitor discharges slowly through the relay coil. Relay does not release until the condenser is discharged. Delayed release only. Time Delay Range—theoretically unlimited. Actual practice indicates an effective range up to 5 seconds. Introduction of a variable resistor in the circuit permits flexible timing control. Instantaneous recycling. This principle may be used to give a short impulse at regular intervals.

Industrial Timer Corporation

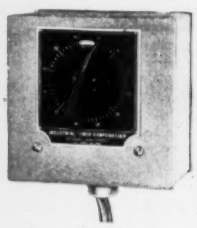
Motor Drive, Dial Form

Representative of this manufacturer's diversified line of synchonous-motor-driven automatic-resetting timers are the following four series:

"M" Series timers are for push-button control, where release of button is required for completing interval and resetting timer. Identical timing period is obtained upon new impetus. Eight standard models.

"P" Series timers afford completion of interval and auto-

"A"



"TD"

"BHR"

matic reset, regardless of push button being open or closed. Timing period of identical duration upon new impetus. Five standard models.

"TD" Series timers are designed to control measured time delay periods. Three standard models.

"BHR" Series timers can be used either to announce duration or completion of timing period, are believed to be the first electrical buzzer signal timers made. Warning lights, gongs, or additional buzzers may also be applied to this timer.

Standard timing ranges are as follows:

Time Cycle	*Dial Calibration*
1—14 sec.	¼ sec.
1—28 sec.	½ sec.
1—55 sec.	1 sec.
5 sec.—2 min. 45 sec.	5 sec.
5 sec.—5 min. 30 sec.	5 sec.
15 sec.—14 min.	15 sec.
30 sec.—28 min.	30 sec.
1 min.—55 min.	1 min.

Custom-built equipment can be ordered for timing operations at both ends of the standard equipment ranges. Heavy-duty self-lubricating motors are incorporated in all models. Units are furnished both in metal cases or un-cased for flush or panel mounting as an integral part of other apparatus. Contact arrangements are available in varying combinations.

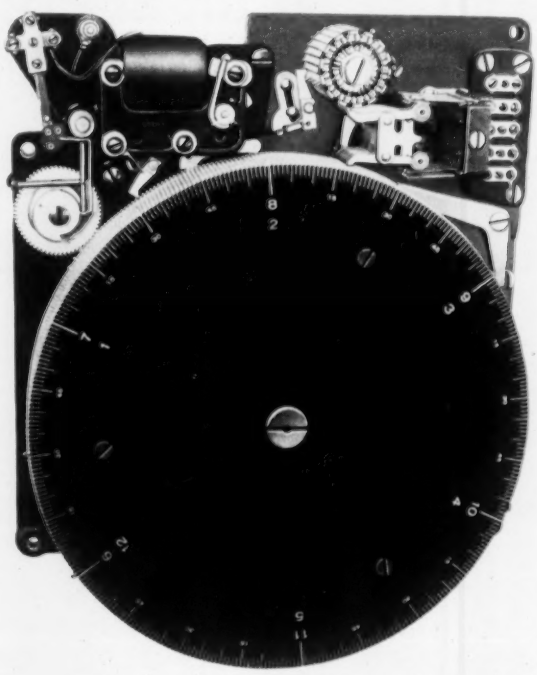
International Time Recording Division Internat'l Business Machines Corp.

General

Manufacturers of self-regulated master program clocks, synchronous-motor program clocks, self-contained program "machines," etc.

Metal Disk Program "Machine"

Originally designed for controlling signals in industrial plants and Program Bell schedules in educational institutions. Because of its flexibility it has been used to provide fully automatic time control according to pre-determined schedule for control of steam supply valves, lights, chimes, warning signals and special experimental work. Operation by electric impulse makes it possible to change the time of the schedule from one week to any period desired. Examples,



the sounding of Westminster and other chimes by the addition of a supplementary drive and automatic cycling control; process timing, such as the curing time in some molding concerns.

The machine functions by the inter-operation of two disks: the 9" Program Disk makes one revolution in six hours and is graduated in minutes and hours. The small Calendar Disk makes one revolution in a week and is graduated in days and six-hour periods. The disks are mounted one behind the other and the assemblies are referred to as the Program and Calendar Drum respectively. The machines are furnished in 8-disk and 12-disk sizes which give complete 24-hour control for two or three schedules respectively. However, because of the flexibility of the machine, only the number of disks necessary for the particular schedule need be used. Schedules may be changed as often as desired by simply shifting the position of the clips on the program disks.

Johnson Service Company

Pneumatic Clocks

These are so called because their function is to operate pneumatic relays, their primary intended application being to Johnson systems of day and night temperature control. As clocks, however, they are made with three different drives:

(a) "Telechron" (all standard a-c. voltages and frequencies),
(b) Hand-wound, spring drive,
(c) Electrically-wound (a.c. or d.c.) spring drive;

and in three different models:
(a) 24-hour,
(b) 24-hour and 7-day,
(c) 7-day.

Each standard dial (24-hour or 7-day) provides for two operations but may be arranged for two "on" and two "off" operations. On order, two cams—providing different schedules—may be mounted on the spindle.

Leeds & Northrup Co.

General

Two different types of time control arrangements, both combined with L&N self-balancing potentiometer (or bridge) Micromax instruments, are offered. One type provides for gradual increase or decrease of the controlled temperature or other variable. The other type provides a cycle of changes determined by the contour of a cam.

Micromax Time-rate Control

This is a built-in feature. It consists essentially of a motor which continuously advances the control-point setter of the Micromax through two worm-and-wheel reducers and a train of gears as shown in Fig. 1, thereby constantly altering the relation between the position of balance in the instrument and the opening of the controlled valve (or rheostat, etc.). Any desired rate of increase or decrease of the controlled variable may be obtained, this rate being uniform by reason of the use of a constant-speed motor.

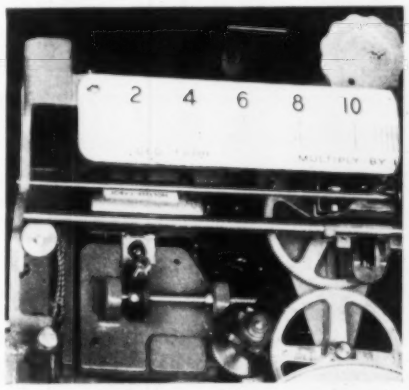


Fig. 1

The total duration of increase or decrease is set by means of an interval timer which is separately housed but is usually located alongside the Micromax. The rate of increase or decrease is likewise externally adjustable by means of a separately-housed control.

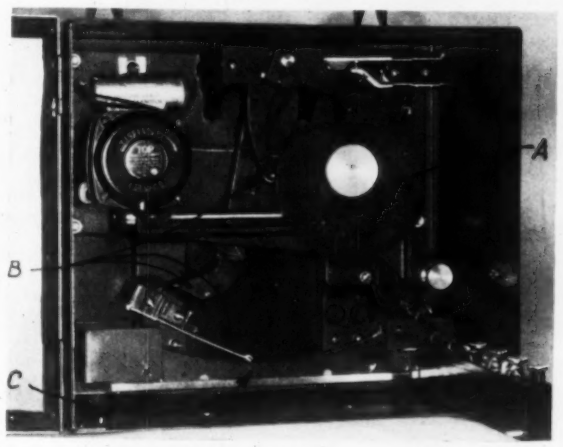


Fig. 2

Micromax Program Controller

This is an auxiliary L&N instrument, in a housing separate from that of the Micromax potentiometer (or bridge) with which it is electrically associated. Its essential features (see Fig. 2) are as follows:

(*A*) The cam which determines the time cycle. Various time ranges are available, by proper selection of reducing gearing. Cams are easily interchangeable.

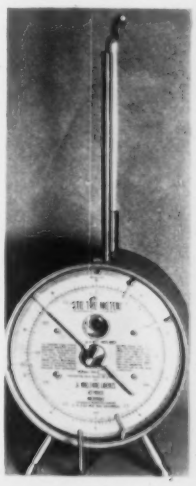
(*B*) Assembly of roller, arm and sliding contact.

(*C*) Slide wire, which *electrically* is a portion of the circuit of the Micromax temperature or pressure recorder-controller.

The recorder-controller in conjunction with which this program instrument is used produces a deviation record in addition to the customary record. The deviation record shows the difference, in degrees or other units, between the desired program and the actual curve, throughout the entire cycle during which the cam had command of the temperature or other controlled variable.

J. Milton Luers

Special Process Timer



The "Ste-Tre-Meter." — This instrument is particularly suited to the time control of steel treating furnaces—the application for which it was developed by the manufacturer (a maker of high-speed steel tools). Distinctive features: zero-return accomplished either by foot lever at bottom or by hand lever at top; "any number" of target contacts may be positioned on periphery; attachment by ring (barely visible at top of illustration) to furnace door whereby opening of door returns pointer to zero and holds it until closing of door starts cycle; two total time ranges (10 and 60 min.) on each instrument, with simple change-over from one to other. Timer is regularly available for 110-volt 60-cycle single-phase supply (others to order).

Mason-Neilan Regulator Co.

Time Cycle Feature for Temperature, Pressure and other Controllers

Most of this manufacturer's standard models of automatic controllers are available in modified forms as temperature-time, pressure-time, etc., controllers, the time cycles being governed by cams easily cut by the user. One modification (Fig. 1) employs a chart-like aluminum cam, the cam-follower being the setting-point arm of the automatic controller. The cam is driven by a recorder clockwork

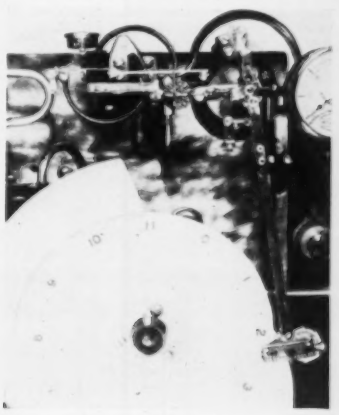


Fig. 1

of the type (spring or electric) and period (1-hour to 7-day) selected by the user. Such a controller, of course, is non-recording.

Another modification (Fig. 2) involves the use of a transparent cam superimposed on top of the customary chart of a recorder-controller and rotating with it. The controller

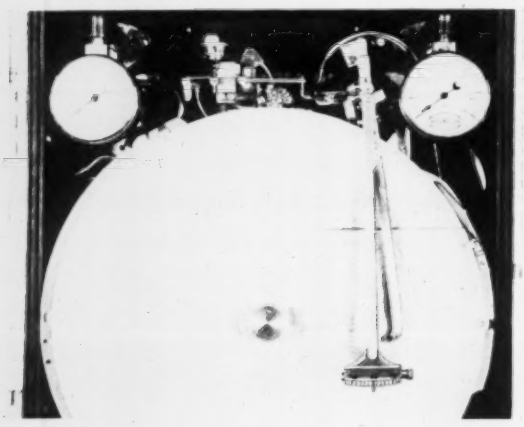


Fig. 2

setting-point arm, instead of being fixed wherever set, is continuously reset as in the previously-described model. The cam is elevated sufficiently from the chart so that one or more recording pens will have freedom of movement beneath it.

Note in Figs. 1 and 2 the graduated and easily-accessible adjustment of cam-follower proper to control-point setting. This minimizes the number of cams required, should the operator desire to change to a higher or lower point in the range.

Minneapolis-Honeywell Regulator Co.

Time Switches and Timers

These have been primarily designed for heating & ventilating, the process-control line being that of the Brown Instrument Div. Typical of the M-H line is "*Type S403A Timer*" designed to control operation of electrical equipment with non-inductive load of 10 amps. at 110 v., 5 amps. at 220 v. or motors of 1 h.p.r.i., $\frac{1}{2}$ h.p.s.p. or $\frac{1}{4}$ h.p.d.c., either 110-v. or 220-v. rating. Timer may be manually set to close the circuit and will automatically break the circuit at a predetermined time for any period from $\frac{1}{2}$ hour to 11 hours. It is put into operation by setting the knob until desired time interval appears on dial. Twisting the knob in counter-clockwise direction will turn current off. Timing mechanism cannot be overwound so that it sticks. "Con-Tac-Tor" mercury switch is of such design that leveling by sight is sufficient in making installation.

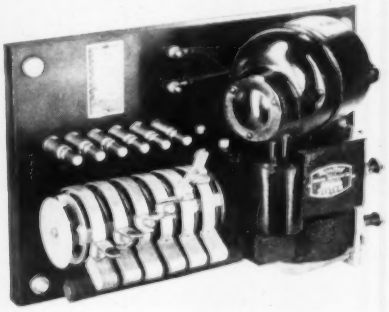
The Monitor Controller Company

"Work-cycle Timer"

Operation of this device may be described as the mechanical closing of one switch after another in sequence and at adjustable time intervals. It can be reset instantly at the starting point at any time during, or after, the completion of the cycle.

The current-carrying switches in a given timer unit are all electrically connected on the pivoted side. Each individual switch consists of a rotatable disk carrying an adjustable contact point and a post fixed on the panel and connected directly to the circuit to be controlled.

There are as many of these little switches as there are circuits in the sequence. The rotatable disks are mounted loosely on a sleeve which is carried on a revolving hol shaft. Each such disk is between two rotating disks t are keyed to the shaft. These rotating disks are equip with carbon blocks that bear lightly against the swi disks. The rotating hollow shaft is driven by a consta speed motor. Through its center extends a clutch rod t can be moved by the action of a powerful magnet.



Normally, the switch arms are stationary with their reset weights resting on the stop bar. If the magnet is excited, the clutch rod is pulled to the right, all the disks are pressed together, and the switches rotate.

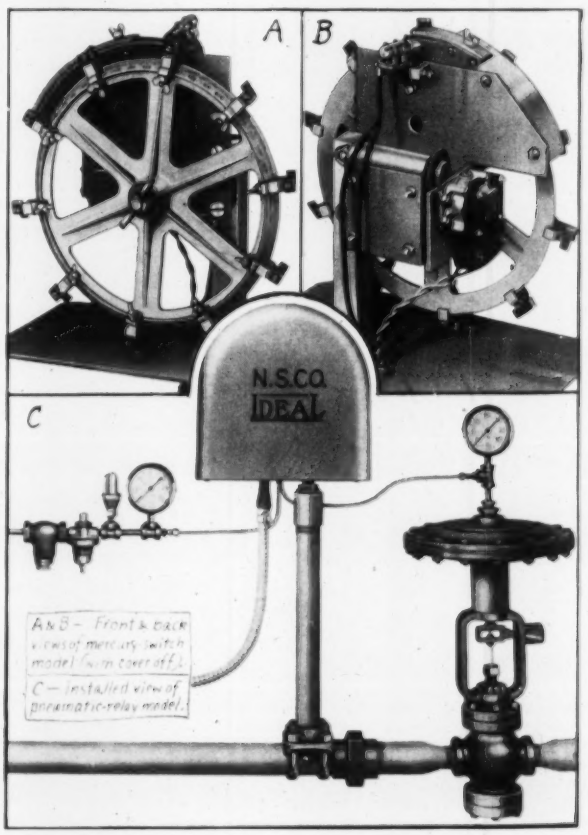
Rotation of each switch continues until it closes on its stationary contact post. From that time on, it simply slips between its driving disks.

When the magnet is released, the pressure is removed from the disks and the reset weights cause all the switch disks to drop back to the normal reset position.

The National Supply Company

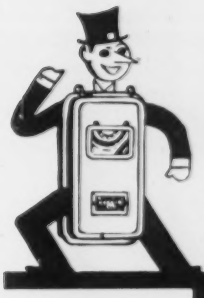
Electric Timers

"Ideal" single-wheel electric timers are driven by electric motors but are available in either electric or pneumatic controller models, for operating electric valves or diaphragm-motor valves. "Type A1" employs mercury switches; "Type A2" employs a low-pressure gas pilot valve. If de-



Paragon *Top Quality* INSTRUMENT

FOR EVERY TIME CONTROL JOB



Submit your time control problem to Paragon. No matter how complicated the operation, Paragon can supply an instrument to control it.

Since 1905, this organization of engineers has been manufacturing and improving timers, time delay relays, time switches and related time control devices. Every Paragon unit is precision built, simple, accurate, rugged, reliable and modern. Paragon instruments are adapted to an unlimited number of industries and applications. Only a few types are illustrated and described briefly here . . . but further information will be cheerfully furnished on request.

400-500 SERIES **Interval Timers, Manual Reset Types.** To time and control any electrically operated equipment or apparatus such as processing machinery, samplers, laundry and dry cleaning machinery, household appliances, therapeutic and diagnostic apparatus, photographic equipment, etc.

800 SERIES **Automatic Reset Time Delay Relays and Interval Timers.** Synchronous motor operated. These time delay relays are to accurately delay the closing or opening of an electrical circuit following a power failure or disconnect of the A.C. operating potential. Or to provide an adjustable time delay between the closing of a pilot circuit and the subsequent closing or opening of the timer load circuit.

900 SERIES **Industrial Timers.** Synchronous motor operated, manual reset. To time and control processes of manufacture such as: Plastic molding, rubber curing, heat treating, enamel baking, liquid agitation, light exposure, pump operation, conveyor operation, watchman signals, power disconnect, etc.

300 SERIES **Self-Lubricating Time Switches.** For controlling signs, commercial lights, attic fans, stockers, oil burners, blowers, pumps, valves. Only two exposed gears, dustproof, 2000% extra dial power. For 24-hour automatic switching.

J SERIES **Time Cycle Repeaters.** For adjustable time cycle repeating. Sixty-six standard models available for time cycles ranging from 1 minute to 6 hours, with 40, 50 or 100% adjustment for the ON or OFF portion of the complete repeating cycle.

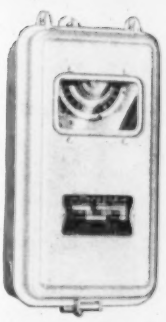
Z SERIES **Automatic Reset Timers and Time Delay Relays.** Offering precise control for thousands of operations.

PROGRAM TIMERS, **Contact and Time Cycle Repeaters.** Designed to repeat a program of "ON" and "OFF" switching operations or momentary contact. Large number of models.

PARAGON ELECTRIC COMPANY
35 W. VAN BUREN ST., CHICAGO, ILL.

300 Series

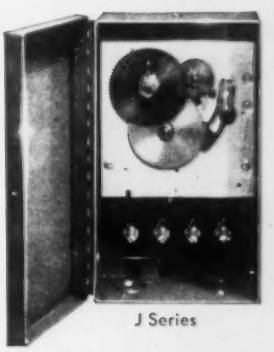
500 Series



G Series

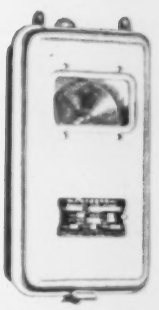
900 Series

400 Series



J Series

800 Series



Z Series

Paragon *Chicago*

BUILDERS OF CONTROL INSTRUMENTS . . . SINCE 1905

sired, *both* mercury switch and pilot valve may be used at the same time (signal light to be flashed while controlled valve is "on"). Driving motor being of synchronous type, a number of timers may have their operations interrelated. Wheel revolution is one or two hours (changed without tools). Ten trip fingers provide ten operation in one hour (or five per hour with 2-hr. rev.). Overall height 17", net weight 31 lbs. Field installation is facilitated by pipe saddle shown in Fig. C.

Northwestern Clock Company

Time Switches, Appliance Timers, etc.

"Unit construction" permits the removal of any part from the case without disturbance to the other parts. Standard make self-starting synchronous motor, slow speed. To this mechanism is added our exclusive switch operating mechanism which is composed of but four main parts. The switch may be operated by hand at any time, without disturbing the time set of operate. The switches used in the Northwestern are Special Alloy Contacts that do not burn or stick. Time switches are available in single- and double-pole, 35 amps. per contact. Steel case size 9" × 6" × 3½".

Appliance timer has the same time-switch essentials but its case is 4" × 4" × 2¼", it is portable, and it is rated at 15 amps.

Paragon Electric Company

General *(from letter transmitting selection of company's literature)*

"We have produced timers since 1902. . . . We believe we are best known for our ability to manufacture special timers. . . . We now manufacture over a thousand different types of timers. . . . "

1. Time Switches

Newest model of this manufacturer's time-switch line is the *"300 Series"* (Fig 1) which has only two exposed gears (the other gears operate in a sealed oil bath and consequently are always lubricated). Operation is not affected by dust, is accomplished by slow-speed (450 r.p.m.) industrial type self-starting synchronous motor. For actuating off-tripper there is a reserve power of 40 lbs. or an equivalent of 2000%. Switch operates successfully at —20°F.

Program clocks and program timers are available also, for applications requiring more than four signals or operations per cycle. There is no limit to the number of operations that may occur, except that there must be a minimum of 30 minutes between signals (on the 24-hr. models).

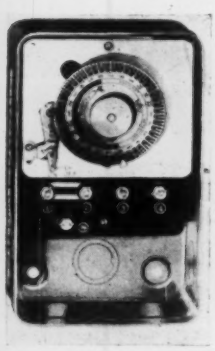


Fig. 1

Fig. 2

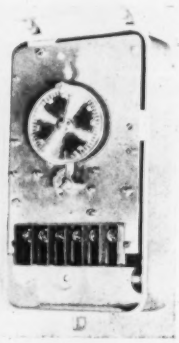


Fig. 3

2. Interval Timers, etc.

Fig. 2 shows a recently-announced example of the manual-reset type. Units are powered by slow-speed self-starting synchronous motors and equipped with "fast-acting silver contact micro-switches." Available ranges extend from seconds to hours. Some models are equipped with start button, with signal-stop button, etc.

3. Automatic-reset Timers, etc.

"An almost unlimited number and variety" of industri operations can be controlled, it is said, by means of n series of automatic reset timers and time delay rela These timers are furnished with eight terminals. A positi mechanical lock, magnetically operated, does away wi friction and magnetic clutches and prevents possibility any disconnect due to vibration. A variety of cases is ava able, for wall mounting, built-in flush panel, meter-socke etc. Fig. 3 shows a wall-mounted model available in vario ranges from ½-13½ sec. to 1-22 hrs.

Some models are available with 8-day spring clock driv

Special-purpose models are available, such as stocke timer relays, stoker or burner timer and time-switch com bination, timer relay and time-switch combination.

Partlow Corporation

Process Timers

"Model 308 Time Delay Relay"—This instrument fo automatically timing the duration of a process cycle com prises a synchronous motor driving a gear train through a magnetically engaged clutch. At the end of the timing

period, a switch operates to stop the timing motor and either connects or disconnects the load as desired. Upon breaking the timer circuit the magnetic clutch releases and the timer automatically resets itself. Timing is adjusted by setting the knob and pointer. The pointer serves as an elapsed-time indicator. Four timing ranges are available in all models: 0-5 min., 0-15 min., 0-50 min. and 0-5 hrs.

Perfex Corporation

Time Switches, etc.

As parts of its day-night control products for domestic-heating installations, this manufacturer offers (1) electric clocks which are combination timepieces and changeover switches, (2) synchronous-motor 24-hour time switches. Both may, of course, be used for automatic timing purposes independently of the maker's thermostats. The clocks are beautiful timepieces in which the time-switch features are concealed and are supplied with step-down transformers as they operate on 20 volts and control a load circuit of 20-volts, 1-amp. rating. The 24-hour time switches operate on 115- or 230-volt 60 cycle supply and control various a-c. loads up to ½ h-p. with s-p.s-t. or s-p.d-t. contact arrangements.

Thermostats with Adjustable Time Action

"Cycling Dial Twin-contact Thermostat No. 150"—This is one of a series of room thermostats embodying an automatic timing feature which provides an anticipatory mode of control:

"In industrial process control, elaborate and expensive instruments employing automatic reset, interval timing, etc., are used to closely approach this ideal. Naturally, such instruments are too elaborate and expensive for the home owner. The inexpensive Cycling Dial Thermostat . . . produces control which leads rather than lags temperature changes, synchronizes heat input with heat losses and elim-

COORDINATED CONTROL

COORDINATED CONTROL consists in the adaptation and coordination of the various instrument controls in a process in order to *fully automatically* produce the desired end product or result. It generally involves the use of a time function or cycle controller, coordinated and interlocked with the several quantitative controls such as flow, pressure, temperature and concentration.

The combinations of quantitative controls possible are myriad. In any given installation, success depends upon:

1. Careful selection of the instruments
2. Proper coordination of the time cycle
3. Reliable means of interlocking and coordination
4. Sound engineering.

A panel of several individual pressure controllers is not an example of COORDINATED CONTROL. But the following is,—a complete recovery control system, consisting of two batch processes operating regeneratively and means for so switching from one process to the other as to produce a continuous result and to maintain constant conditions of concentration and flow of production. Such an installation should be and is made up as a unit, and tested and shipped as a unit. When it is installed in your plant—aside from external power and valve connections—it also operates as a unit.

A system of COORDINATED CONTROL can be designed to function on any one of several different cycles. In such instances a cycle selector is installed that allows the process to follow any one of the several predetermined procedures.

COORDINATED CONTROL consists of more than just instruments. Applying the best engineering to the coordination of various controls, it encompasses the full responsibility, from the beginning to the end of the cycle, of producing the right results at the right time. It has been successfully applied to many processes of drying, sterilization, recovery, and catalytic treatment. There is no limit to the quantities and variations that can be coordinated.

To industry the benefits of modern COORDINATED CONTROL are a saving in time, lower production costs, and a uniform product of predetermined quality . . .

The Bristol Company
Waterbury, Connecticut

BRISTOL'S

inates overshooting and undershooting in a manner never before attained. The Cycling Dial is a calibrated internal adjustment. Its function is to accurately adjust the intervals of stoker or burner 'on' periods. . . . This feature is not obtainable with any other thermostat on the market."

[Functionally, the Cycling Dial feature is an interval timer of the thermal class, bimetal type. Structurally it resembles an adjustable time-delay relay of that class and type. In addition to the interval adjustment manually operable by user there is a heater adjustment (governing max. and min. interval) which is made at the factory but which service men may make in the field.—EDITOR]

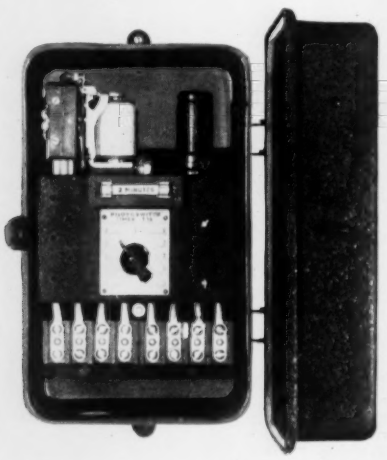
Stoker and Burner Time Controllers

Both synchronous and thermal types of interval controllers and time-delay relays are incorporated in most of the Perfex Corp.'s control systems for stokers and for oil burners. The synchronous-motor type, though housed in a case which contains other components, is essentially a "sequence" or "cycle-stop" automatic timer with one-hour dial.

Photoswitch Incorporated

Universal Interval Timer

"*Electronic Timer Type T15.*"—This is an interval timer, for ranges from 1/20th second to two minutes. Control is accomplished through a snap-action relay of 1,000-watt capacity. It is "universal" in several ways, one being that it may time an operation or it may introduce a delay. Equip-



ment is flexible with reference to actuating control, permitting both momentary push button and sustaining contact control. It is "universal" also in that the timing may be changed. Thus six timing ranges are represented by timing valves snapped into a readily-accessible clip. Timer has been designed to permit complete interchangeability of equipment. Thus, machine process calibration for one timer apply to all. It is claimed also that unit has been designed throughout for an unlimited guarantee to match that of any machine to which it is applied.

Photovolt Corporation

Portable Process Timer

"*Photrix Electronic Timer*"—This is a precision timer originally designed for dark-room use where settings may be in hundredths of a second. It is available in standard models with timing ranges up to 100 seconds including double-range models) for controlling loads up to 1500 watts a.c. or 1200 watts d.c. Employing a network of capacitances, resistances, etc., it has no moving part other than the circuit-closing and -opening relay. Timing is determined by electrical constants whose values are negligibly affected by temperature, humidity, aging, etc. Timing scale of each dial is geometrically progressive, or logarithmic, so that limit of error is nearly a constant fractional-percent of the duration for which the dial has been set. Thus, intervals down to 1/10 sec. are timed accurately. Electrical timing method obviates need of rewinding or resetting: pressing the push-button closes the load circuit, which is opened au-

matically at end of interval for which dial has been set, independently of how long push-button is held down. Right-hand toggle switch is for keeping load circuit closed when experimenting, etc. Unit illustrated measures $6\frac{3}{4}$" × $3\frac{1}{2}$" × $4\frac{1}{2}$".

Production Instrument Company

Combination Timer and Recorder

The "*Signal-Graph*" was originally designed for mechanical connection to the machine, but the newer model is controlled by an electric switch and may be located at any distance from the machine or other equipment. In operation, it signals the operator when the processing period for

which it has been set has elapsed, and automatically stops the processing—the next processing cycle being started by the operator pressing a conveniently-located button. In addition, the instrument records the processing time of each operation, as well as the loading or inactive time, on a chart graduated in minutes. Being operated by a synchronous motor it measures time with the accuracy of an a-c. electric clock. It is available in two models, with timing ranges of $\frac{1}{2}$ to 27 min. and 1 to 54 min. respectively. The indicating dials are graduated in half-minutes and in minutes, respectively. Switches, signals, etc., to complete each installation are furnished by the Production Instrument Co.

M. H. Rhodes Incorporated

"Mark Time" Interval Timers

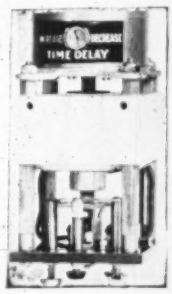
Portable Models.—These are spring-clock type, wound and set by turning the knob-and-pointer. Though most models are designed for use with domestic appliances, they find laboratory and plant applications to load circuits under 10

Dependable Time Delay For Your Product . . .

AGASTAT

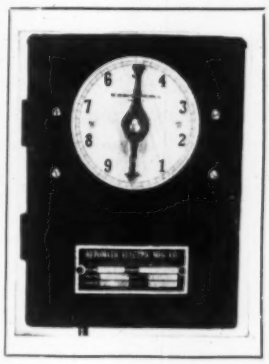
- UNAFFECTED BY DUST DIRT OR TEMPERATURE
- SET SCREW ADJUSTMENT FOR DELAY INCREASE
- FOR USE WITH EITHER AC OR DC CURRENT
- DIVERSITY OF TIMING EFFECTS POSSIBLE
- POSITIVE SNAP-ACTION TYPE CONTACTS

This time delay unit is gaining popularity in industry for unfailing dependability. Its diversity of timing effects — from a fraction of a second to several minutes and its adaptability to either AC or DC circuits make it particularly useful for delay control under severe conditions. Descriptive bulletin N-4 available on request; no obligation.



AMERICAN GAS ACCUMULATOR CO.

ELIZABETH ELECTRICAL DIVISION NEW JERSEY



"Automatic" TIME CONTROL DEVICES

Models for

Any desired time cycle
Any function specified
Any performance wanted

PROCESS TIMERS

INTERVAL TIMERS, or PROCESS TIMERS, are furnished in two types. One is reset by hand (manually); other resets itself automatically. Both types can be provided for practically any cycle of time, fully adjustable from zero to maximum period. SYNCHRONOUS, SELF-STARTING MOTORS.

SIGNAL TIMERS

Used extensively for starting and stopping industrial work; school class periods; for municipal time signals, etc. Up to six signal periods, permanently set at factory with Sunday & Holiday Cutout and Manual Control, at a price of only $35.

TIME SWITCHES

Triple Pole • Double Pole • Single Pole

All three types can be furnished with capacities ranging from 20 TO 200 AMPERES PER POLE, from $12.00 up. Ten ampere Time Switches from $3.95 up.

Write for Information

AUTOMATIC ELECTRIC MFG. CO.
MANKATO, MINNESOTA

There's a G-E TIME SWITCH for Every Purpose

TYPE TSA-10 *for*

Accurate, Adjustable INTERVAL TIMING

In manufacturing processes where accurate, *interval* timing is an important factor, this time switch can help you make savings in workmen's time, reduce waste and spoilage, and increase product uniformity.

WIDELY ADAPTABLE

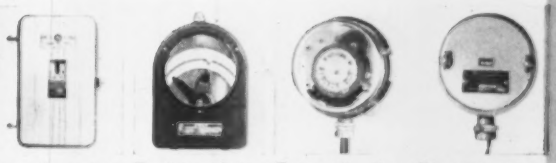
The Type TSA-10 is an automatic switch for the control of machines or processes where accurate timing is extremely important. It will provide time-delay opening or closing of a contact and then reset, or hold the contact closed (or open). It provides adjustable, automatic control of "Open" or "Closed" time, control of starting time, or of the interval of consecutive processes.

TYPICAL APPLICATIONS

This time switch can be used to control hydraulic presses, tire molds, plastics molds, photographic printing machines, paint mixers, signaling devices, and many other machines.

For further information call the nearest G-E Office or write for bulletin GEA-1771. General Electric, Schenectady, N. Y.

G-E TIME CONTROL DEVICES



General-purpose switch—Send for GEA-1427 | For interval timing—Send for GEA-1771 | For cyclic timing—Send for GEA-2963 | Electric time meter—Send for GEA-3299

GENERAL ELECTRIC

660-2

amps. Ranges (total) are 60-sec., 15 min., 30 min., 1 hr. and 5 hrs.

Industrial Models—These are similar in operation but are for built-in application. Five standard dials: 60 sec. to 5 hr.

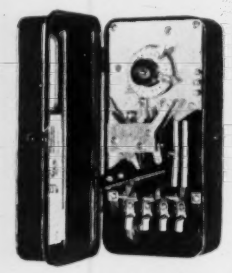
"No. 806 Mercury Switch."—This is a wall switch (flush mounting) with a six-hour timer of the "self-wound" spring clock type and a mercury switch rated for continuous duty on a ¾ h-p. motor: 10 amps. 125 volt d.c. or a.c. 5 amps. 250 volts a.c. or d.c.

Sangamo Electric Company

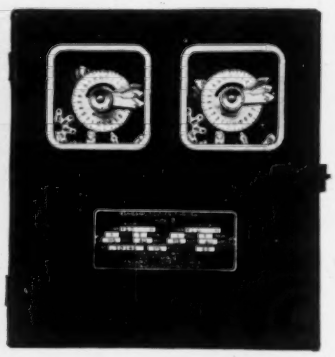
Time Switches

The complete line of Sangamo electrically operated time-switches can be divided into: (1) synchronous motor; (2) synchronous motor with electrically wound carryover; (3) electrically wound. All three can be supplied for use on a-c. circuits. The electrically wound mercury-tube contact type can be supplied for d-c. circuits. All are subjected to a test run at 75% of rated voltage.

Manual Operation—Either the "on" or "off" levers can be operated manually without affecting the sequence of subsequent operations. Knobs for tripping the time-switch manually without opening the cover can be supplied on many of the models.



Two-circuit



Duplex

Frequency of Operation—All time-switches, except astronomic, two-circuit or specials, are arranged for three complete daily operations, allowing for either one, two or three "on" and "off" periods each day. On all silver contact switches, minimum time limits between the "on" and "off" operations are 30 minutes, and between the "off" and "on" 2½ hours. Time-switches having these time limits reversed can be supplied when specified. On the mercury-tube contact types, the minimum time limit between operations is 15 minutes.

Five models of enclosing cases: conventional; socket mounting; outdoor (with or without window); conduit type base, and meter type base.

The *advance time cutoff* performs an "off" operation at a time different from the regular setting of the switch. This device is not required for *astronomic dial* time-switches, as the "off" operation can be normally set for any time between 9:30 p. m. and 2:15 a. m. if desired.

Momentary contacts can be supplied in tube-contact type time-switches by special tube arrangement. Intervals from ½ to 10 seconds can be supplied. Time-switches with momentary contacts are built to order, consequently require additional time for shipment.

Several forms of Sangamo time-switches can be supplied in the *two-circuit* construction. The "on" and "off" operations of each circuit are entirely independent of each other. Following an "on" operation an "off" operation can be obtained after 30 minutes. Following an "off" operation an interval of 2½ hours must elapse before the next "on" operation can be obtained. Reverse operation, reversing the time limits between "on" and "off" operations can be supplied. It is possible to supply this reverse operation for one circuit while using regular sequence of operation on the other circuit.

The *Duplex* time-switch consists of two separate switch units operated by the same timing mechanism. It can be supplied either with the synchronous motor or with electrically wound movement. With separate switching units, the sequence of "on" and "off" operations of one unit can be set independent of the switching operation of the other.

Instantaneous-reset Timer

"Model 15 Instantaneous Reset Timer."—Designed to operate as a time delay or time limit relay or as an interval timer, this is a modification of the standard Sangamo time-switch. It consists of a control coil, a slow-speed self-starting synchronous timing motor, and a 3-position contact mechanism with two silver contacts. In the normal position both contacts are open. When the control coil is energized, the first contact closes and the timing motor starts to run. At the end of the time set on the dial, this first contact opens, a second contact closes, and the motor stops.

Any time the control coil is de-energized, whether or not the timer has completed its operation, it will instantly return to normal position with both contacts open.

Line and load connections are made directly to motor and contacts. The control coil may be operated from the same line: two wires are run from the timer to an ordinary snap switch or its equivalent. Closing the switch starts the timer; opening the switch resets it. By running three wires from the timer to the control point, a start-and-stop push button station may be used.

The control coil may also be connected to a separate line, usually in parallel with some other device. Applying current to the coil starts the timer, disconnecting the current resets it. This arrangement is useful when the first device is controlled automatically, as by a float valve or pressure switch. It will perform a second operation a given time after the first, or if the first is not complete within a given time.

There are eight standard dials: 5, 10, 15 and 30 minutes; and 1, 2, 5 and 10 hours.

Continuous-repeat Timer

The *"Model 11 Timer"* for opening and closing circuits on a pre-arranged schedule comprises a self-starting, synchronous motor which drives a camshaft through a train of gears, and a cam-and-contact arrangement to insure quick closing and quick opening of the contact regardless of how slowly the camshaft revolves. The gears can be arranged so that the camshaft will make one revolution in one minute or longer. Commonly-used timings such as even hours or even minutes can usually be obtained exactly without special gears. The "on" period can be easily adjusted in the field from approximately 0 to 50% of the cycle. If specified it can be arranged for 50 to 100% instead. The timer may be built with any number of contacts operated by the camshaft. The cycle, being determined by the gears, is not adjustable, but the "on" period of each contact is independently adjustable. Pure silver contacts are rated at 5 amps.

Adjustable-speed Timer

The *"Model 14 Gear Change Timer"* provides a repeating cycle of "on" and "off" intervals with maximum adjustment: (1) The length of the "on" period may be varied between 5% and 95% of the cycle, by setting ON and OFF levers on a dial; (2) The length of the cycle (1 shaft rev.) may be varied by changing gears mounted on the front plate with thumb-screws—an operation requiring no tools. The base cycle of a timer is the shortest possible cycle for that timer. The complete range is from one to twenty-four times this base cycle. Gears below 60 teeth produce two cycles, one in each range. Each timer is regularly supplied with a choice of any 10 change gears, additional change gears being obtainable. The timer operates on 115-volt 60-cycle a.c. and has a capacity of 5 amps.

Combinations for Complex Sequences

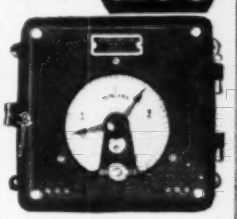
Two or more of the timers described above (or others not described) may be combined into one assembly to provide a specified cycle with specified adjustments. Absolute synchronism between the units of the assembly, or independence of certain elements, or flexibility in this respect, may be provided to suit various industrial requirements.

Automatic TIMING

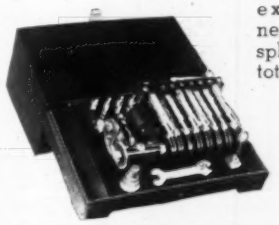
... by atc

Dependable Control Over Process Periods or Process Actions

Accurate control of processes and operations on the basis of TIME, is a major business with ATC. Installations, numbered in the thousands, are daily paying their way with most reliable—therefore most economical—performance. Standard models will start, stop or repeat operations on one to forty load circuits. Adjustment can be exactly what is needed, down to a split second. The total cycle can be seconds or any number of hours.



An ATC Dial Timer available in 40 standard adjustable types



An 8-circuit Cam Timer used to control eight steps of a process

Send for BULLETIN G-10

Representatives in Principal Cities

AUTOMATIC TEMPERATURE CONTROL CO.
25 E. Logan St. Philadelphia, Pa.

BARBER B-C COLMAN

Remote
BULB-TYPE MICROTHERM
for PROPORTIONING
CONTROL of MOTOR-OPERATED
VALVES

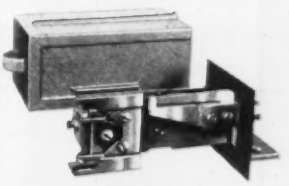
VEE-PORT VALVE with Type CYBG OPERATOR

● Bringing the advantages of the highly accurate and fully automatic Micro-Control System to processing operations. The Bulb-Type Microtherm may be installed in vats, tanks, ovens, coolers, stills, washers, or the like and will control remotely located valves to govern the flow of gas, air, steam, water, or other liquids. Write for further information, stating the type of service contemplated.

BARBER-COLMAN COMPANY
1202 ROCK ST. • ROCKFORD • ILLINOIS

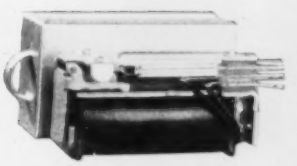
RELAYS
by AUTOMATIC ELECTRIC

Automatic Electric relays and stepping switches are the perfected products of over fifty years of experience in the design and manufacture of electrical control equipment, and are available in a wide variety of types to meet the most exacting needs. A few typical designs are shown below.



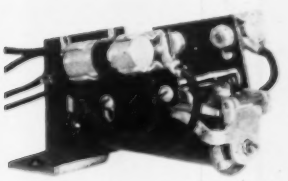
QUICK ACTING D.C.

Series AQA. Rating to 300 volts, D.C. Range of operating times .002 to .025 sec. Release times .005 to .025 sec. Single wound relay is standard where the rapid closing and opening of a number of circuits is required. Multi-wound relay is supplied for special purposes.



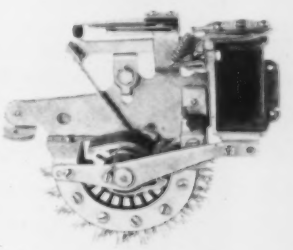
QUICK ACTING A.C.

Series FQA. Rating to 240 volts, 16 to 66 cycle, A.C. Range of operating times .002 to .025 sec. Release times .005 to .040 sec. A quick acting, general purpose A.C. relay for operating a number of contacts.



MERCURY CONTACT D.C.

Type 12. Rating to 300 volts, D.C. Range of operating times .24 to .28 sec. Release times .18 to .27. Contact made and broken within metal tube—no dangerous exposed sparks.



STEPPING SWITCH D.C.

10 point switch. Rating 6 to 120 volts, D.C. Remote control or self-cycling operating. Handles 4 conductors per circuit. Maximum of 30 pulses per second. Larger capacities also available.

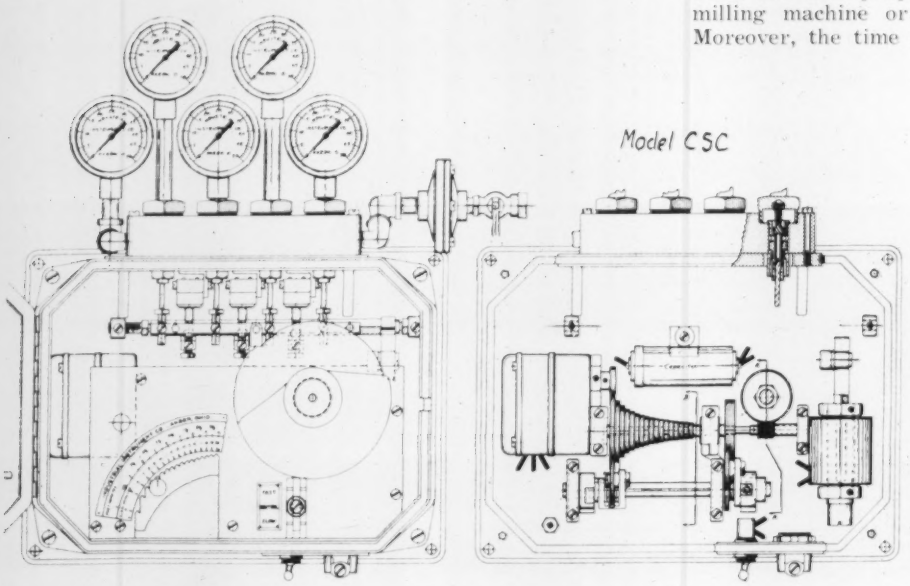
For complete information, write for catalog 4071-IP covering our entire line of relays and remote control devices. If you have any special control problems, give the facts when writing for catalog and we will specify the best type for your purpose. Address: American Automatic Electric Sales Company, 1033 W. Van Buren Street, Chicago, Illinois.

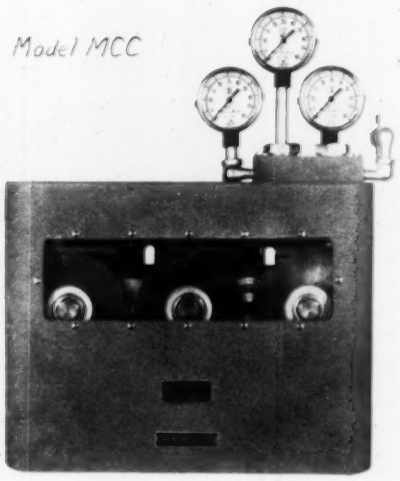
AUTOMATIC ELECTRIC
ELECTRICAL CONTROL APPARATUS

Seely Instrument Co.

Process-cycle Controllers

This firm manufactures seven different time-cycle controllers, each available in various models; most of them actuating either switches or pneumatic relays; some of them so designed that electric and pneumatic units may be interchanged. Latest development is remote command from a row of push buttons which may be located at the convenience of the operator or supervisor.





"Model CC."—This appears to be the simplest type. It is an air-operated condensation controller, continuous-speed split cam, producing four or eight openings during the cycle, depending on the condensation discharge requirements of the processing equipment (such as a platen press).

"Model EC" is an all-electric single-cam cycle control with reversible motor. Principal method of use: obtain a given sequence followed (when push button is presse by an exactly reversed sequence.

"Model CSC" (illustrated) is said to be unique in th any of twenty-seven different speed ratios, between the sy chronous motor and the cam, may be selected. The arrang ment for this purpose is generally similar to that in milling machine or in a screw-cutting lathe headstoc Moreover, the time ratio of one operation to another ca also be varied by rotating cam segments with respect to the main cam.

"Model MCC" is similar to the foregoing in its adjustability, but is a three-cam instrument. Each cam may actuate two pilot air valves or micro switches. Each cam may be driven at a speed different from that of the others, but correlated thereto by reason of synchronous motor and positive-drive gearing.

Stromberg Electric Company
Stromberg Time Corporation

I. Endless-tape Type

Fig. 1 shows the essentials of a *Stromberg Tape Type Program Instrument* (removed from the panel where switches and other accessories are mounted). These instruments may be used to control electrically operated valves in gas, water and steam lines; to start and stop motors; and, in general, for any purpose involving the opening and/or closing of electrical circuits at predetermined times. Any number of circuits or schedules can be controlled. *Contact Mechanism:* The edges of the endless cellulose tape are printed to show definite divisions of time. When the tape is punched according to these designations, a definite program is established which permits contacts to be made only on the desired time schedule. Each tape can be used for two distinct schedules, and separate programs may be set up on the same instrument. Any program may be omitted on certain days. A new schedule merely requires the punching of a new tape and placing it on the instrument, which can be done in a few minutes by anyone. The schedules may cover periods of twenty-four hours or less as desired. The Program Instruments can be operated as independent synchronous-motor units or as part of a master clock system.

II. Dial Type Process Timers

"Process Timing and Signalling Instruments"—These are Warren-motor-drive instruments, available in manually-reset, automatically-reset and continuously-repeating models. One of the basic instruments may be furnished by itself, or it may be supplied mounted on a panel with relays, electro-magnet actuators, magnetic switches, etc., whereby a plurality of processing periods can be automatically timed.

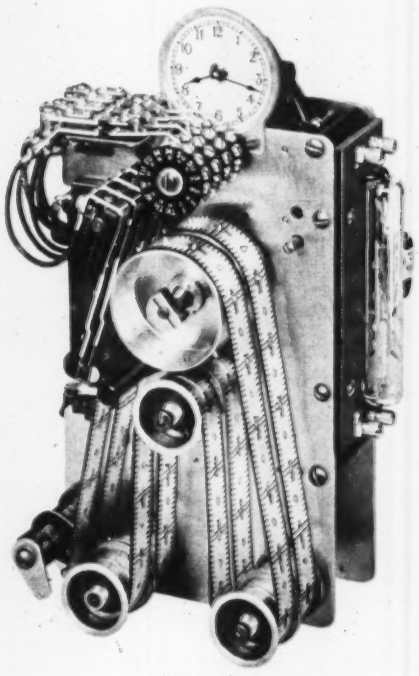


Fig. 1

Some processes can be made entirely automatic by the use of "No. 56" (non-repeat but automatic set-back) and "No.

TIMERS & TIME DELAY SWITCHES

SINGLE OR MULTIPLE CONTACT CYCLE TIMERS

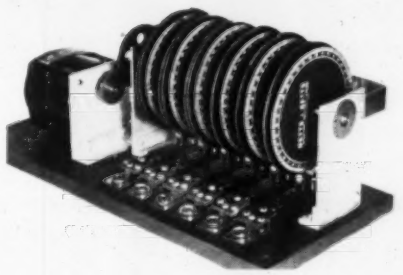
TIME DELAY RELAYS

IMPULSE TIMERS

FLASHERS

CODE CONTACTORS

SIGNAL CONTROLS



★ Illustrated is the adjustable Segment Process Timer, one of the many models of Betts & Betts Cycle Timers built to specification. Available from the wide range of Betts & Betts timers are continuous repeat action or instantaneous reset types. Also thermostatically controlled or motor driven Time Delay Relays for any load and any application.

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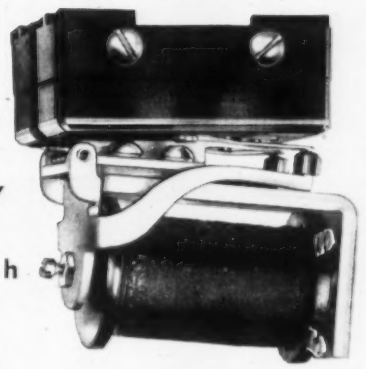
CLARE *Type "G"* Micro-Switch RELAY



Particularly adapted for aircraft, machine control, motor and lamp loads, photo electric and similar applications where space and weight are factors. The type "G" Relay is furnished to operate on d.c. only.* Contacts rated at 10 amperes, 110 V., a.c.—completely enclosed. Solder or screw type contact terminals optional.

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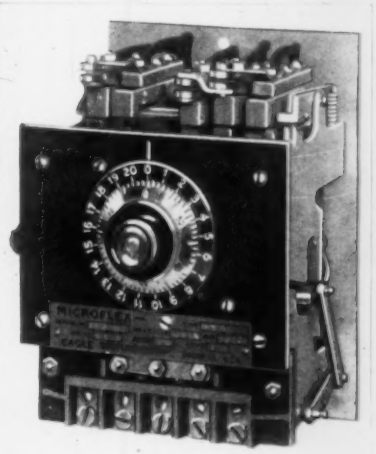
WHEN YOU REQUIRE A RELAY TO LIMIT THE NUMBER OF OPERATIONS IN A PROCESSING CYCLE—SPECIFY THE — — — — —

EAGLE MICROFLEX RESET TIMER



AN INSTANTANEOUS RESET TIMER

- FULLY AUTOMATIC
- UNUSUALLY ACCURATE
- SYNCHRONOUS MOTOR DRIVEN
- AUTOMATICALLY RESETS
- VISUAL DIAL SETTING

CHRONOFLEX INSTANTANEOUS RESET TIMER: An ideal Reset Timer for Automatic Machine Control problems. Shows progress of cycle as time expires.

Bulletin No. 266.

MULTIFLEX RESET TIMER: For multiple circuit applications. Circuits are independently adjustable on a calibrated scale to close and open at any time during the time interval.

Bulletin No. 260.

FLEXOPULSE REPEATING CYCLE TIMER: Continuously closes and opens an electric circuit as long as power is supplied to the unit. The "on" and "off" time is independently adjustable on the dial.

Bulletin No. 265.

MICROFLEX INSTANTANEOUS RESET COUNTER: This instrument counts impulses and is suitable for limiting the number of operations of almost any electrically controlled mechanism. The compound dial is adjustable from 1 to 400 impulses. The counter resets automatically after each counting cycle.

Bulletin No. 261.

The Microflex Timer is a relay for limiting the number of operations of a machine or an operating member in a processing cycle. It is particularly well adapted for use in control circuits of automatic machine tools and process controls in which a contact is to be closed or opened for a predetermined length of time.

APPLICATION — The ideal Reset Timer for controlling Hydraulic Presses, Violet-Ray Apparatus, Photographic Printing Equipment, Rubber Curing Equipment, Plastic Molding Devices, Grinding Machinery, Laboratory Instruments, Centrifugals, and other devices whose accurately timed functions are essential to industrial progress.

See Bulletin No. 255.

EAGLE SIGNAL CORP.
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57" (repeat-cycle) in combination with each other. Fig. 2 shows the "No. 55" which is the simplest of this series, its function being to close (or open) a contact at the end of the interval for which it is set. However, it differs in several ways from the conventional type of simple interval timer. For example a lock is combined with setting button C, so that the time setting may not be altered by an unauthorized person.

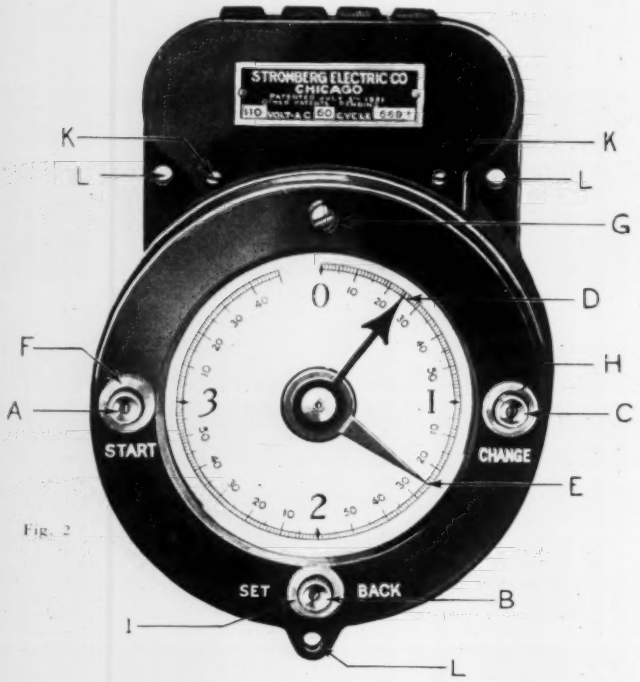

Fig. 2

Models 55, 56, 57 (and the "A" models thereof) are available in various total time ranges, the shortest being 3 min. 48 sec. and the longest 3 h. 12 min. In all ranges it is possible to obtain definite contact durations as well as predetermined adjustable intervals.

C. J. Tagliabue Mfg. Co.

General

Shortly after the turn of the century this company brought out automatic timers in which a spring clock drove one cam which actuated one pilot air valve.

Various features were added one by one to the standard cams, so that different schedules could be obtained by means of one cam. The adjustable gradual-rise-period feature (adjustable without tools) made possible the adjustment of temperature-time and pressure-time cycles.

Various features were added also to the temperature and pressure control instruments with which the time-cycle controllers were combined. . . . Various features were added to other parts of the systems. . . . Thirty years ago the TAG line of automatic timers already included "master" instruments for automatizing and coördinating processes in the rubber, textile, food, chemical and other industries.

During and after the First World War, industry's need of more and more complex time cycles led to the design of specialized control systems. . . . Electric control was added to pneumatic control. The increasing reliability of regulated-frequency a-c. supplies in industrial centers led to the adoption of synchronous motors (but note that high-grade clockworks are still preferred today in some instances). About 1924, TAG multiple-cam instruments for coördinated control of several processing equipments from one point began to be standardized. . . . Process discussions not being acceptable in this write-up, the most interesting reports of savings, etc., must be omitted and the following descriptions pertain exclusively to the timing functions of TAG process control instruments.

The functions of the TAG time control instruments and time control features may be roughly divided into:

(1) Process Time Control. This is the function of the original TAG Automatic Time Controller which closes (or opens) a diaphragm-motor valve at the end of the interval for which it is set.

(2) Time-temperature control (or time-pressure control). This is the function of the original TAG instruments in which a rotating cam gradually alters the setting-point of a temperature or pressure system.

(3) Time-temperature-condensation control (and similar dual functions). Such a dual function is accomplished by one cam of exclusive design which governs two thermal systems and hence *four* diaphragm-motor valves.

(4) Time-temperature-condensation control with automatized cooling and draining. Generally as in (3), plus a second cam which performs two functions: (a) cooling for a definite length of time and (b) draining.

(5) Process Cycle Control. This covers numerous functions, some cycles being relatively simple and some involving intricate sequences of operations, automatic safety tests, etc.

Cams for Air-operated Controllers

TAG time-curve cams for actuating pilot air valves are available in three principal forms:

Fixed.—This type is frequently made up with two or three different cycles cut on its periphery, thus serving the purposes of two or three individual cams.

Semi-adjustable.—This type is a fixed cam to which is added a trip arm positioned on the cam spindle next to the cam, whereby the duration of the holding period (following a heating period, for example) can be set.

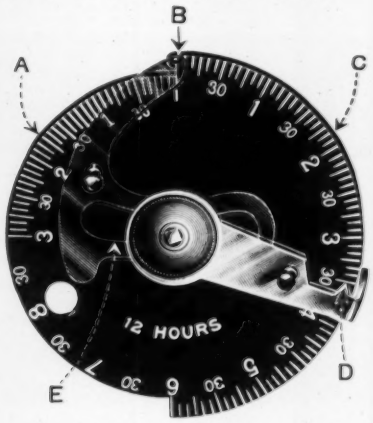

Fig. 1

Aujustable.—This type (Fig. 1) has trip-arm D for duration of holding period C, and also an adjustable rising-period member E, hinged at B, whereby the duration of the rising period is adjustable. Member E is transparent in order to facilitate reading the time graduations on portion A when setting for rising period.

Time-temperature (etc.) Controllers

Numerous models of TAG automatic controllers in which cams actuate pilot air valves to provide gradual changes in temperature, pressure, etc., preceded and followed by automatic "on" and "off" actions, are available. Some events are timed absolutely and other events are timed relatively to conditions, as in the example which follows:

"*No. 280.*"—This is a two-cam, two-thermal-system controller which automatically operates five diaphragm-motor valves according to the schedule charted in Fig. 2. This is a

AUTOMATIC OPERATION	DIAPHRAGM MOTOR VALVE POSITIONS				
	STEAM INLET DIR ACT D.M.V.	CONDENSATION DISCHARGE DIR ACT D.M.V.	BLOW-OFF DIR ACT D.M.V.	WATER INLET DIR ACT D.M.V.	WATER DRAIN DIR ACT D.M.V.
	A	E	D	C	B
START OF CURE	OPEN	OPEN	SHUT	SHUT	SHUT
DURING CURE	OPEN, THROTTLING OR CLOSING	OPEN, THROTTLING OR CLOSING	SHUT	SHUT	SHUT
END OF CURE	SHUT	SHUT	OPEN	SHUT	SHUT
AT END OF VARIABLE PERIOD OF TIME COOLING WATER ENTERS	SHUT	SHUT	SHUT	OPEN	SHUT
AT END OF 2ND VARIABLE PERIOD OF TIME COOLING WATER DRAIN OPENS	SHUT	SHUT	SHUT	OPEN	OPEN
AT END OF 3RD VARIABLE PERIOD OF TIME COOLING WATER SHUTS OFF	SHUT	SHUT	SHUT	SHUT	OPEN

Fig. 2

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to 2½ KW

VOLTS
to 250 AC/DC

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. . . for AC or DC Operation —

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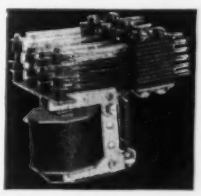
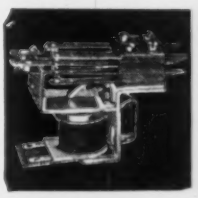


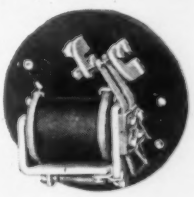
ALTERNATING CURRENT RELAYS

Series 30 AC. (left) Supplied in three types of mountings, voltage range .1 to 440 volts, contact capacity 42 contacts. Size 2¾x1½x2½".

Series 110 AC. (right) Compact, economical, widely used unit. Four pole, double throw contact capacity, 220 volt limit. Size 2¾x⅞x1 15/16".

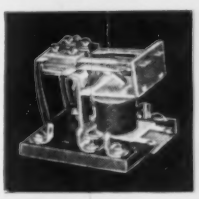


DIRECT CURRENT RELAYS



Series 5 DC (left) Current draw as low as .009 watts—furnished completely enclosed—contact limit, double pole, double throw. Size 3¼x3¼x2".

Series 115 DC (right) Four pole, double throw contact capacity, rapid change over of contacts, full floating, permanently locked armature, economical of space and cost.



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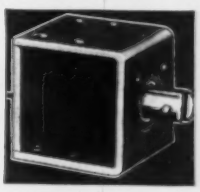
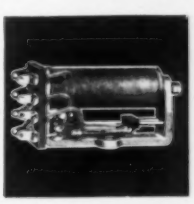


SOLENOIDS —AC; DC

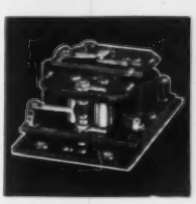
Type No. 2. Efficient—powerful—compact. For electro-mechanical operations involving remote control of mechanical motions such as electric counting, valve control and operation, faulty material ejector, automatic brake, electric racheting, etc. 1½x1½x1⅝".

GOVERNMENT APPROVED RELAYS



BK-10 RELAY (left) Precisely counter-balanced to resist extreme vibrations. Built to rigid U.S. Signal Corps specifications.

BK-16 RELAY (right) Built to minimum tolerances. A production line product. Furnished to custom-built specifications. Another Signal Corps Relay by Guardian.



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schedule, not a mere time table. (Note the variable periods.) The application to which Fig. 2 refers is a tire-curing press.

Cycle Controllers

This designation was not applied to the first camshaft types introduced in 1924 by this company for coördinating a plurality of interrelated processing functions. Each model was given a descriptive name. In 1928, when the diversity of functions performed by eight or more cams made it inconvenient to add the requisite number of words, this type was simply called "Cycle Controller." Note, however, that this same designation has since been applied to some standard *single-cam* TAG controllers which do not produce gradual changes but perform sequences of "on" and "off" operations. The devices immediately actuated by the cams of TAG Cycle Controllers may be pilot air valves, or electric switches, or both in one instrument. These relay elements, in turn, operate a variety of devices including hydraulic cylinders (and whatever other means are required in each application) directly or by intermediate hydraulic or other relays.

Thus the variety of TAG Cycle Controllers is too great for description in the allotted space. Only one example of each general type will be given.

Camshaft Type.—Fig. 3 shows a multiple-cam Cycle Controller with a "ten-hour clock" which is the main drive motor, a "30-minute clock" which is a small synchronous motor, as well as some fifty other features enabling it to serve as a master controller whereby a tire press is completely automatized and safety tests performed automatically. The schedule is as follows:

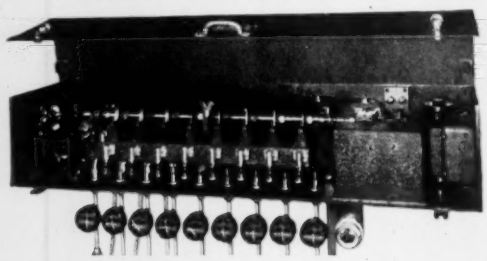

Fig. 3

Start: Time, 0:00.—Operator opens hydraulic valve. When hydraulic pressure reaches 800 lbs. (or as set), a hydraulic pressure spring causes the resetting electric motor of the controller to rotate the entire camshaft, bringing all cams to their starting point. Camshaft stops.

Time, 0:05.—Immediately the 30-minute electric clock starts to rotate the leak test cam 38* and this cam causes diaphragm valve 9* to open, allowing air to enter the air bags for a 5-minute period. At the end of five minutes valve 9 closes and then begins the 1-minute bag leak test.

If the air bag pressure falls 5 lbs. during the 1-minute test period the 30-minute clock will be stopped by a differential pressure arrangement in the controller and red signal light 16 will summon the operator. The operator must then correct the faulty condition and restart the 30-minute clock by turning cam 38 with a special key until lever 39 is opposite a mark on the cam. The air bag leak test then repeats itself but if the air leak has not been eliminated, so that during the second leak test more than 5 lbs. is lost in one minute, the controller will again stop and the red lamp 16 will again light.

Time, 0:06.—(If the air leak test has been successfully passed) —The ten-hour electric clock driving the main cam shaft starts and the controller automatically begins the curing by opening steam inlet valve 3 and condensation valve 33. The thirty-minute rising period and the two-hour hold are accomplished by cam action as in other TAG controllers.

Period 0:06 to 2:36.—A safety provision is the auxiliary (or standby) steam inlet tube system. There are two complete and duplicate steam inlet cams, air valves and thermal systems, which operate throughout the cure. Steam inlet diaphragm valve 3 is furnished with a duplex top 4, one diaphragm section of which is connected to the regular steam inlet thermal system 10 in the controller. Now if, at any time during the cure, the regular thermal system 10 should leak or become inactive, the cure will be handled without interruption by the auxiliary 11. The possibility of both thermal systems failing during the same cure is remote.

At the end of the cure or at 2:36.—Steam inlet valve 3 and condensation valve 33 close. Blow-off valve 30 opens for 3 minutes.

Time, 2:39.—Blow-off valve 30 closes. Water inlet valve 2 and water drain valve 31 open for thirty minutes.

Time, 3:09.—Water inlet and water drain valves both close. Steam inlet valve 3 and condensation discharge valve 33 open for ten-minute mold-heating period for easy removal of tires.

Time, 3:19.—Steam inlet valve 3 and condensation discharge valve 33 close. Blow-off valve 30 opens.

Air bag inlet valve 35 closes and air bag relief valve 8 opens, venting the pressure in the bags. Pressure switch 19 simultaneously lights green lamp 15, announcing the finish of the cure. The ten-hour clock of the controller stops automatically when the hydraulic pressure is released to open the press.

Throughout the Entire Cure.—Whenever the hydraulic pressure falls from 1500 lbs. (its normal pressure) to 1200 lbs., or less, the air bag pressure will automatically be vented by valve 8 and the air inlet line shut by valve 35. A total failure of the hydraulic pressure is exceedingly unlikely by reason of complete safeguards against this event (e.g., each hydraulic pump has a duplicate standing by ready to start should the regular pump fail). However, before the standby pump can bring the hydraulic pressure back to 1500 lbs. the pressure will drop momentarily and then a release of the air bag pressure is desirable. This is accomplished automatically as just described. Of course when the hydraulic pressure has been restored, valves 8 and 35 return to their former positions, with vent line closed and inlet open.

The construction of the cams used in this Cycle Controller is such that the time periods can be readily adjusted. The adjustment of the temperature time cam, for example, permits of increasing the duration of the hold period up to almost twice its minimum length. The adjustments of other time periods are likewise adequate.

It is not amiss to note that this Cycle Controller was one of the earliest cam-shaft models developed, its manufacture becoming standardized in 1928—the year in which the above schedule was written.

Single-cam Type.—One of the earliest and simplest of this type of Cycle Controller (Fig. 4) was designed specifically for the automatization of platen presses. The following description of its operation is abstracted from an article in the March 1931 *India Rubber World:*

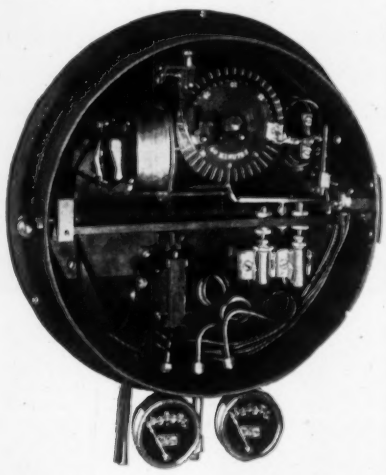

Fig. 4

"The controller is so arranged that when the operator has a press loaded he needs only turn the handle on the controller case front to a stop pin. This brings the cam to zero, starts the Warren electric clock running and operates the Stuart two-pressure hydraulic valve which closes the press. The controller, being set for the desired cure, will automatically open the press at exactly the correct time and keep it open until the workman unloads, reloads and again turns the handle on the front of the case.

"A small handle at the right hand side of the case is an emergency press-opening device: Should a workman become caught as the press is closing or if for any other reason he finds it necessary to open the press after he has started the timer in operation, he simply turns this handle a quarter turn, thus forcing down the main lever, operating both pilot valves and opening the press.

"Once the emergency device has been used, the press is locked in the open position until the foreman unlocks the controller door and releases a latch on the emergency. This prevents operators from using the emergency as a means of operating the press independently of the controller and thus shortening cures, which would defeat the whole idea of automatic timing.

"The internal construction of the controller consists of the electric clock, zero reset device, sub-lever, main lever and two pilot air valves identical with those used in tem-

*Numbers in this schedule refer to a diagram which would take up a page in *Instruments;* its omission does not seriously "spoil the story" of the operation of the controller illustrated in Fig. 3.—Editor.

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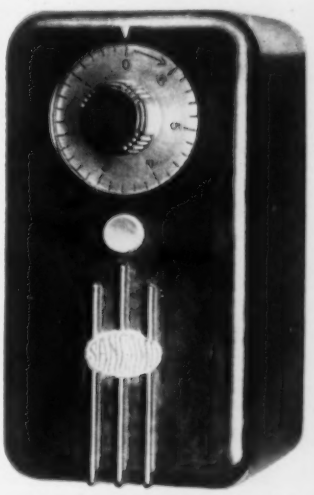
SANGAMO TIMERS

Sangamo Timers are accurate and dependable instruments used for controlling or totalizing time intervals. Operated by a low-speed, self-starting, synchronous motor, they can be fastened to any wall or panel, and are readily attached to the ears of any standard switch-box. Size: 5¼" high, 2¾" wide, 2¾" deep.

MODEL 12 INTERVAL TIMER

The Sangamo Model 12 Interval Timer is a manually set timer which will automatically open or close a circuit at the end of a selected time interval. One timer may be used for both operations, for example, to close the circuit to a signal when the circuit to another device is opened. The basic circuit is closed by turning the dial to the desired time interval. This starts the timer, and at the end of the interval the dial will read zero, and the basic circuit will open. An auxiliary contact, which will close at this time, can be provided. This auxiliary contact may be opened by turning the dial to the "off" position.



MODEL 12 INTERVAL TIMER

MODEL 17 TIME METER

MODEL 17 TIME METER

The Sangamo Model 17 Time Meter is designed to measure the total length of time a circuit is closed. By connecting the meter into the circuit of the motor on a punch press, lathe, or other machine, the total operating time is recorded. It is invaluable in determining if existing apparatus is being fully utilized. The time meter consists of a synchronous timing motor driving a cyclometer dial through a train of gears. The dial changes continually and always presents an up to date record. Readings may be taken hourly, daily, weekly, or at any convenient interval, to provide a basis for comparison.

Model 12 is described in Sales Circular No. 196.
Model 17 is described in Sales Circular No. 197.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

perature controllers. These pilot valves are operated simultaneously but, as one is direct-acting and the other reverse-acting, air is admitted to one end and vented from the other end of the double-acting air cylinder of the Stuart valve. The air pressure employed is 55 lbs.

"This controller not only opens the press at the end of the cure but 'bumps' the press at any point or points during the cure as often as the schedule calls for. The long concentric slot in the cam permits location of the bumping sections wherever desired. The bumping is performed just as a skillful operator would do it: the press is opened far enough to allow the escape of the gases which have been generated and then reclosed, this action being repeated as often as the bumping section has notches. The controller may be quickly and easily reset for any cure from 1 to 40 minutes and longer cures can be arranged if necessary."

Cam-equipped Potentiometer Controller

The "*TAG Celectray Potentiometer Program Controller.*"—This instrument is a combination. It is this company's photoelectrically-balanced potentiometer type automatic controller, with the addition of a single switch and of the program slide-wire unit shown in Fig. 5. This program unit comprises a motor-driven cam upon which rides the roller of the contact levers, a slide-wire rheostat, switch and battery.

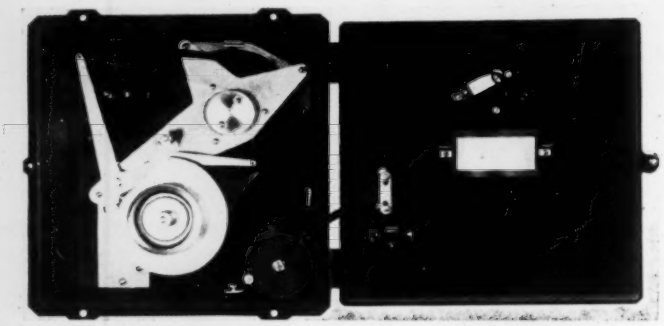


Fig. 5

Through the window of the instrument the time dial and index marker show the cam being rotated. Correct temperature is indicated by the position of the light-beam on the window of the controller. The operation of the instrument consists merely in standardizing the potentiometer current and the program slide-wire current, setting the program cam and turning on the switches. The temperature of the controlled equipment can be checked at any time by throwing a switch and balancing the potentiometer without disturbing the time-temperature program. Red and green signals will appear in the window of the controller should accidents throw the temperature appreciably off schedule.

Chart-cam Type

"*Twin Case Program Controller.*"—This is a combination of (1) a 12" size air-operated type temperature or pressure

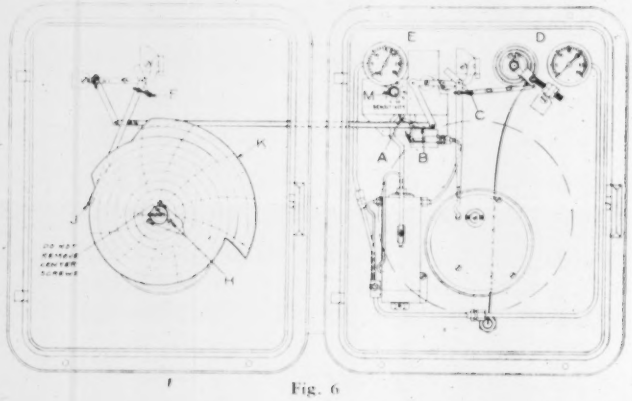


Fig. 6

recorder-controller and (2) a cam driven by a separate clock and housed separately, but governing the control-point setting of the temperature or pressure controller.

Taylor Instrument Companies

Multiple-function Sequence Controller

Instead of a multiplicity of cams, a number of grooves in a drum and in each groove one or more actuating pins: s... is the chief distinctive feature of the "*Flex-O-Timer T... Cycle Controller.*" This instrument (Fig. 1) is adapta... for all-electric, all-pneumatic operations, or combinations of both. Extreme flexibility is obtained and cam cutting is eliminated by the use of adjustable pins on the revolving drum: pins fit in circumferential undercut grooves on the one-piece drum and are locked in place with a screw. Each air valve or switch can be turned on or off within 0.5% of total cycle time.

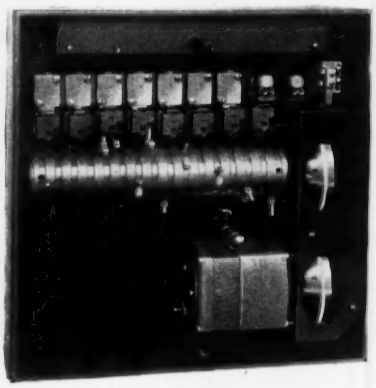


Fig. 1

A latch-trip solenoid-operated mechanism starts the process instantly. This actuates one or more snap operators to start the timer motor (high-torque fan-cooled synchronous type) and any outside electrical or pneumatic functions to be performed simultaneously at start of cycle. An external push button or limit switch can be used for this starting impulse. Where diversity of products being processed requires considerable variation in processing time, the Flex-O-Timer provides 78 different drum speeds with each gear train ratio, yet the drum speed is fixed for any given setting and can vary only as a-c. supply frequency changes. Models are available also with a fixed-speed gear train.

The low-leak air valve "believed to be the most highly leakless type available," utilizes 99½% of the air passed through it. Air valve plunger is so designed that air supply port cannot at any time communicate with exhaust port, assuring rapid and full air pressure application and release. It is said that dirt particles are sheared off by close fit of piston, then exhausted from system, making this valve practically self-cleaning.

Fig. 2

Single-cam Cycle Controller

Fig. 2 shows the "*112R Precision Set Variable Speed Timer*" for vulcanizers, tire presses and platen presses, which makes possible overall timing of the cure as well as sequence of the various steps and functions of the cure, so that individual operator works to greatest efficiency. Seven standard gear ratios provide seven ranges of time adjus...

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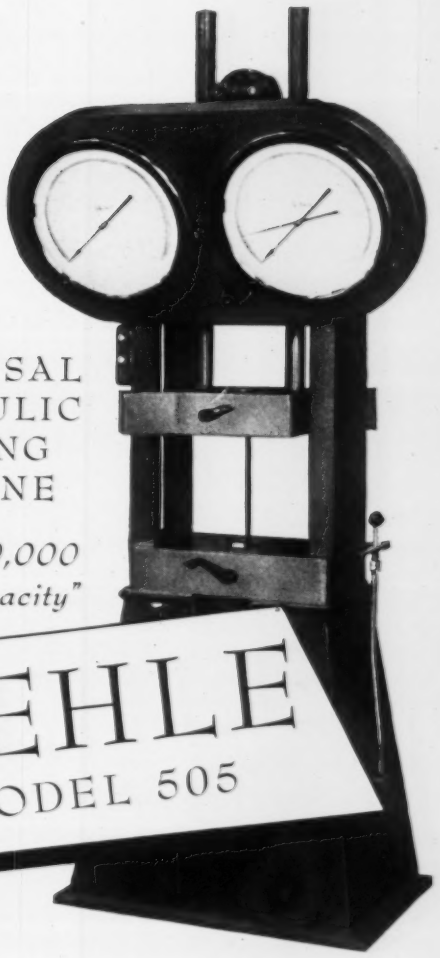

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★ Testing speeds marked on large scale in inches per minute.
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ment, for each of which there are 80 different speeds of cam revolution. Adjusting the timer from one speed to another is easily and quickly done by hand. Mercury switches are connected to solenoid air pilot valves of the lock-in type so that in case of electrical failure during a cure, the valve will not change position.

Process Timer for Temperature (etc.) Controllers

The "*Process Timing Mechanism for Fulscope Controller*" is a device built into either recording or non-recording temperature or pressure controllers. See Fig. 3. It is driven by

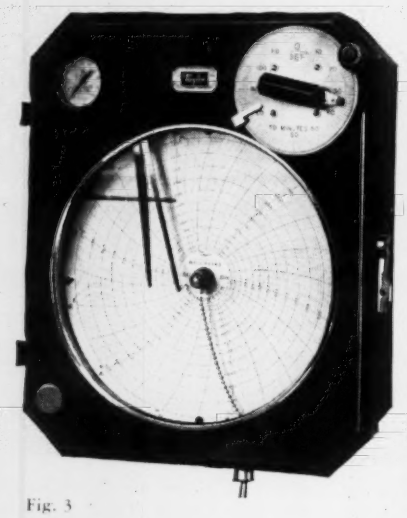


Fig. 3

a synchronous motor. It is not an ordinary interval timer: the timing process is manually started by adjusting the instrument for desired time period. Timing automatically starts, not immediately, but when the apparatus reaches the set point of the controller. (Length of time required for this set point to be reached makes no difference in the operation of the new timing mechanism.) At end of desired period, mechanism automatically terminates the process. A pointer-stop facilitates timing successive batches of the same duration: when set at the desired timing period, the pointer can be quickly spun to this stop. Stock timing ranges are 2 and 24 hours; special dials are 1-, 4-, 6-, 8- and 12-hour and 7-day. Timer operates on 110-volt 60-cycle supply (others available).

Chart-cam Type

Fig. 4 shows the "*Fulscope Time Schedule Controller*" in which a chart-cam type time controller is associated with an air-operated temperature, flow, pressure or liquid-level controller. The right-hand case contains the recording chart and a "Fulscope" controlling mechanism with universal sensitivity adjuster (see *Instruments*, April 1934, page 81) by means of which process time lag is met and throttling control assured. The left-hand case houses the cam and rotating mechanism and the several auxiliary devices to perform additional functions in the process. The desired time schedule by which the controlled temperature, pressure, flow or liquid level is changed, is cut on the cam: As it rotates, a rider is moved in accordance with its contour. This motion is transmitted through a suitable linkage to the "Fulscope" control systems in the right-hand case, to change the control point. This correspondingly varies the air pressure delivered by a pilot air valve to the diaphragm-motor of a control valve, which in turn changes the flow of the controlled medium to the apparatus under control. An auxiliary trip air valve can be operated at the end of or at any point during the process, to turn on or off air pressure to a diaphragm-motor valve. Also, a trip switch can be combined with this trip valve to sound an alarm when this operation takes place. If a complete schedule does not comprise a whole cam revolution, the cam can be made to continue its rotation to the beginning of the cycle and then be stopped by an automatic clock stopper. A tumbler switch is provided to cut out the cam motor circuit at will. Both cam and chart are rotated by separate electric clocks, which may or may not be of the same periods of revolution.

Sequence-repeat Controller

Instead of employing a conventional cam to time t intermittent operation of a diaphragm valve or other d phragm-operated device, the "*Taylor Intermitter*" (Fig. has a circular cam on which the proper number of actuati lugs may be placed; the number (up to 20) correspondi with the number of operations to be performed during t rotation of the cam. The duration of each operation is a justable by moving the bracket carrying the nozzle (upp left corner of case) so that its scribe mark is opposite th

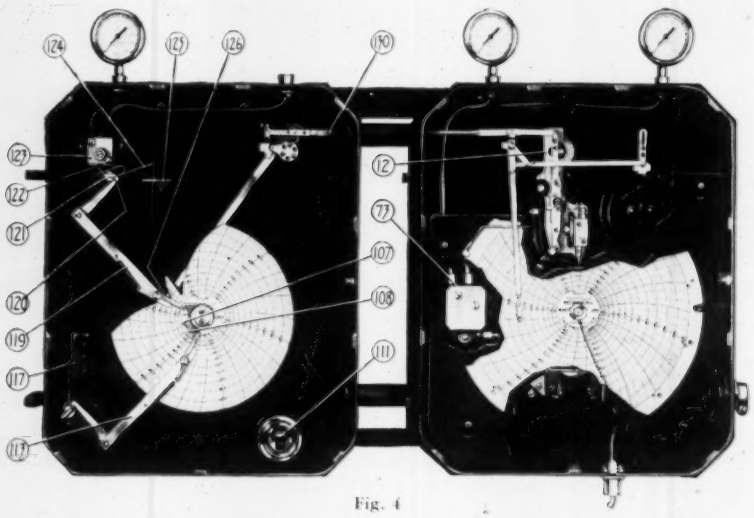


Fig. 4

desired time interval on the scale: the higher the position of the nozzle, the shorter the period of nozzle closure and the duration of operation. Any change in either the number or durations of the operations, or the interval between operations, is thus made possible without replacing the cam.

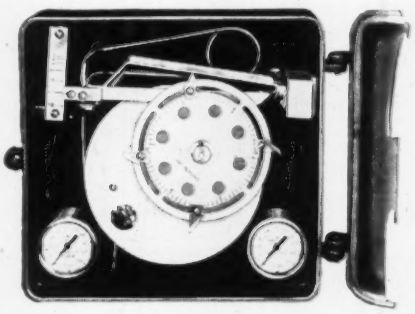


Fig. 5

The cam is driven by a spring or electric clock, available in 1-, 6-, 12- or 24-hour periods of rotation. The instrument is available in two types—Reverse-acting: lugs to close nozzle, applying pressure to diaphragm motor. Direct-acting: lugs to open nozzle, relieving pressure from diaphragm motor. It may be mounted on any diaphragm motor or in any convenient adjacent location. Also, it is possible to operate more than one diaphragm valve or similar device from the same instrument, the number depending upon the operating conditions and the nature of the control required.

The Tork Clock Company, Inc.

General *(from letter transmitting company's literature)*

" . . . Production is now almost exclusively concentrated in time switches and timers that are timed and powered by self-starting synchronous motors. . . . "

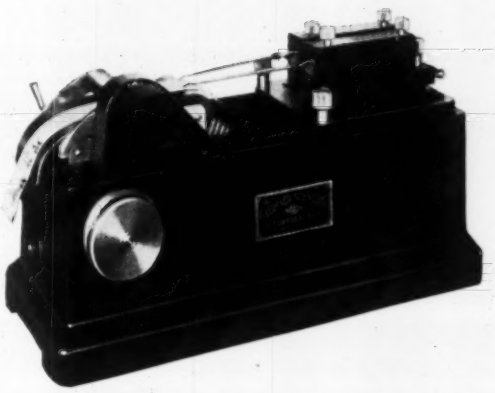
[EDITOR'S NOTE—For use on d.c. or unregulated a.c. this company manufactures also time switches and timers with 8-day hand-wound movements and mercury switches.]

Time Switches

"Little Giant" Models. There are four of these, differing only in capacities and in arrangements of load circuit contacts. Motor is maker's own Type P sealed-design slow

GAERTNER

CHRONOGRAPHS



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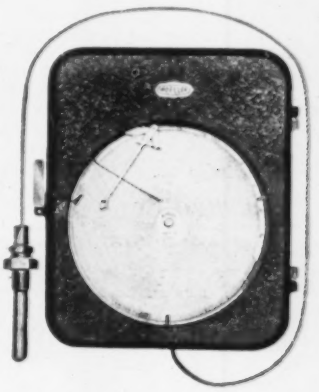

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speed self-starting synchronous motor wherein all parts running faster than 8 r.p.m. run in oil. Settings are made to 1-min. accuracy. The "on" and "off" arms are adjustable in 15-min. steps. The cadmium-finished pressed-steel case is fitted with twelve knockouts. Single-pole models control up to 3800 watts; double-pole, up to 7500 watts equally divided.

For heavy-duty (25 to 100 amps. per pole) a Tork Clock operates the holding coil or coils of a contactor. Several combinations are available.

Timers

"*No. 6191.*" This is a sixty-minute repeating timer similar in appearance to the "Little giant" models of time switches except that the dial completes its rotation in one hour. By means of additional pairs of arms, this hourly-control timer can be made to serve as a 30-min. cycle timer (two cycles per dial revolution), as a 20-min. timer (3 cycles per rev.), etc. Switch capacity is 20 amps. per pole.

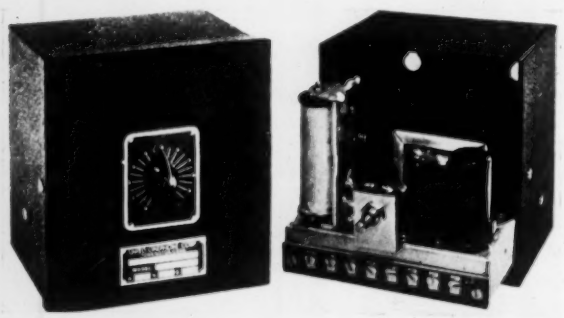
"*No. 6191X.*" This variant of the foregoing is a single-set timer with 60-min. maximum interval. The clock stops automatically at the end of the interval for which the timer has been set.

"*No. 4191.*" This model is available for continuous operation or for single operations in exactly the same manner as No. 6191 or No. 6191X, the only difference being that the 96-hole dial revolves in four hours and the indicating slots are spaced 2½ minutes apart.

United Cinephone Corp.

"Electronic" Timers

"*Electronic Timers*" is the designation of a series of adjustable-interval timers, any of which may be obtained to work either from the momentary closure of the external switch, or from the sustained closure of the external switch (but not from both). In the first instance, operation will take place after the external switch has been depressed



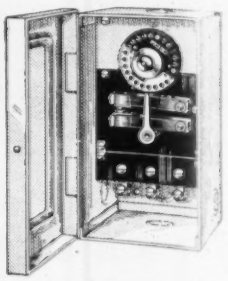
and returned. In the second instance, the timing will begin immediately the switch is depressed. Operation from sustained circuit closure allows more accurate timing than the other type.

All models operate from 110-volt 60-cycle supply, consume approx. 5 watts. A three-winding transformer is used to furnish correct operating potentials to the vacuum tube. All parts are operated well under ratings. Three timing ranges: 0.05-0.5, 0.1-10 and 1-100 seconds, all steplessly adjustable. Models for any range may be had with s-p. d-t. contacts handling 3 amps. or 15 amps. (non-inductive at 110 voltc a.c. in either instance); the 100-second model may be had in a unit (employing enclosed mercury plunger type relay) with normally-open contacts, handling 30 amps. 110-v. non-inductive load. Box dimensions 5⅛"×5⅝"×3¾".

The Wadsworth Electric Mfg. Co.

Time Switches (24-hr. and 1-hr.)

All clock movements in this manufacturer's line of time switches are removable from the cabinet by loosening (not necessary to remove) one screw. They are powered by self-starting synchronous motors and are available in 24-hour and in 1-hour periods of rotation. Two-circuit instruments are available, comprising two complete clock movements and associated switch contacts, the clock movements being two 24-hr., two 1-hr., or one of each. Two contact arms per dial is standard equipment; four per dial are available. The switch contacts are pure silver or copper, button type, mounted on Bakelite arms and producing (when operated by the clocks) a wiping action said to be an exclusive Wadsworth feature which keeps contacts clean and assures quick make and break. Motors are available for operation from 60-, 50- or 25-cycle 115-volt a-c. supplies and from 60-cycle 220-volt a-c. supply. Contact arrangements (*s*-p. s-t. or d-p. s-t.) are available for handling 115 or 230 volts a.c. at 35 amps. per pole. Single-circuit cabinet dimensions, 7¼"×4"×4"; double circuit cabinets 7½"×7¾"×4".



Walser Automatic Timer Co.

Introductory Statement *(from letter transmitting selection of company's literature):*

"Our timers are of the standard clock-operated type. They are designed, primarily, for mounting to machines and appliances which require built-in units for tme control of current or for signalling purposes. Our series No. 80 and 86 timer models, however, are widely used in industrial plants for process timing control. The No. 80 is our original timer, introduced some twenty years ago, and along with the No. 86 type, is our sturdiest unit.

"The timers regularly listed are classifiable into pointer and dial operated and lever operated models; also into switch equipped type (normally "on" or "off") and self-contained bell (bell ringer) units. The standard stock models provide a selection to suit particular requirements as to switch capacities and type as well as operating methods; also for flush dial or external mounting, as well as portable, requirements. Numerous variations from standard are available. . . . The advantages of one type over another are relatively unimportant and can only be determined by the adaptability of a particular model to the timing problem, price limitation or dimensional or design requirements in-

Portable Timers

"*Model 521.*"—This is one of several portable timers provided with cords and plugs. It is designed for a.-c. operation

only. It is mounted in Bakelite housing with celluloid-covered chromium dial. The silver contact switch has a capacity of 15 amps. at 125 volts a.c. Timer can be supplied in 15-, 30- and 60-minute maximum timing range. To operate, pointer is turned to any desired interval; for short interval settings (between zero and star) pointer is turned to star to close switch circuit and then returned for interval required.

Interval Timers

"*Series 80.*"—These contain the standard Walser manually-wound clock movement. Their operation is simple: turning the pointer to the time interval desired closes the switch

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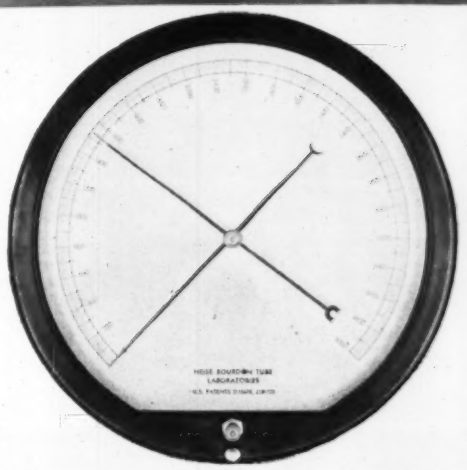

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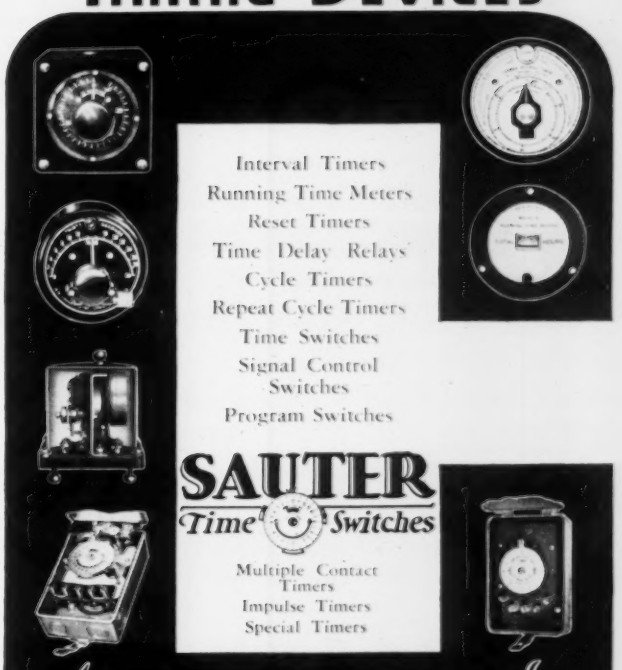

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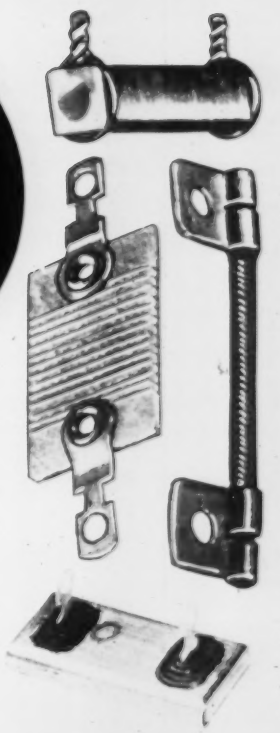

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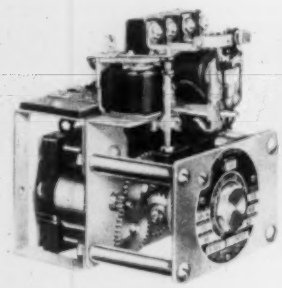
(or opens it when so wired on double-throw type), which will open (or close), automatically, after the set time has elapsed. (For short intervals—less than approx. 10° pointer rotation—the pointer must be returned for setting after the switch has been tripped.) Settings may be changed at will, forward or backward, without affecting the timing mechanism. For panel installation this timer, with or without housing, may be made with special mounting ring soldered to dial assembly. By this means the timer is fastened to front of panel through countersunk screw holes in ring. The "A" housing is 4" in diameter and 2⅜" deep. These timers are available in 0-30, 0-60 and 0-120 minute timing ranges; and are supplied with 6-amp. s-p.s-t. or s-p.d-t., or 15-amp. s-p.s-t. standard toggle switch.

"*Series 86.*"—These timers are similar to the "Series 80" in operation but the movement is larger and more rugged; and the switch is 20-amp. d-p. porcelain-base.

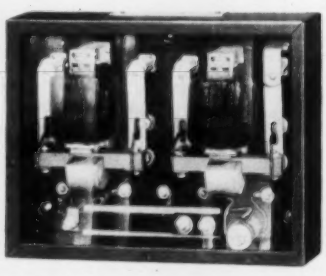
Ward Leonard Electric Co.

Time Delay Relays

The "*Bulletin 362*" *Motor-driven Time-Delay Relay* is available in seven timing ranges: 35 seconds, 1¾, 5¼, 12¼, 26¼, 42 and 63 minutes. Actual timing is adjustable from zero to maximum but the recommended minimum is 8 to 10% of each range. The relay, designed for 60-cycle a-c. operation, consists of a small synchronous motor, a gear



"Bulletin 362"



"Bulletin 351"

train, a tripping arm and a magnetically-operated brake. Nine contact arrangements are available, for 2 amps. per pole (125-250 a.c. non-inductive) and similar ratings, suitable auxiliary power relays being made by the same company.

"*Bulletin 351*" *Thermal Time Delay Relays* utilize the action of a built-in thermostat. When current flows through the heater element of the thermal unit the increase in temperature actuates the bimetallic element closing the relay coil circuit. Correction for changes in ambient temperature is accomplished by the use of an additional thermal elements. These relays are available in three types: "Bulletin 351" for applications requiring immediate recycling, "Bulletin 352" and "Bulletin 353" with lower ampere ratings are for applications that do not require immediate recycling.

The recycling relay provides a preset time delay, regardless of interruptions during the delayed time period, and immediate and automatic recycling. The others recycle immediately but an appreciable time lag is required between operations to reestablish the original time setting.

The standard time range of the "351" is 15 to 30 seconds (120 maximum); of the "352" or "353," 3 to 15 seconds standard (45 max.). Various contact arrangements are available.

Warren Telechron Company

12-hour Sequence Controller

The "*Telechron Organizer*" is an electric clock (a handsome one), around the dial of which are 48 keys, each representing a 15-minute period. "When a key is pulled out it will turn on the radio for the indicated period. When more than one successive key is pulled out, the radio will operate for the corresponding number of 15-minute periods." [Other applications will suggest themselves.—Ed.]

"Telechron" Motors and Instrument Movements

The "Telechron" Motor is a self-starting, synchronous motor which utilizes the principle of residual magnetism to enable a rotor to start and to operate at synchronous speed. This type of motor differs from common forms of a-c. motors in that eddy currents, induced either in the mass of the rotor or in some form of winding upon the rotor, are not utilized to start the motor from rest. Instead, the rotor is made of such magnetic material and is so proportioned with respect to the field that remanent magnetic poles are set up in the rotor material by the a-c. magnetism of the field in such a manner as to cause the desired motion. Such a motor, sometimes known as a hysteresis motor, can be designed to operate at absolute synchronous speed as well as to start from rest and attain this speed practically instantaneously.

There are more than ten distinct types of "Telechron" motors, some of them developed especially for instrumentation applications. There are available also standard combinations of motors, reducing gears, etc., ready for use as chart movements. Complete timers with switches, etc., are made up as specials.

Weltronic Corporation

Welding Timers

"*Model 108-53 Timer-Contactor*" (Fig. 1) is for use with any 15- to 35-kva. manually- or mechanically-timed spot welder. Available for 220-, 440- or 550-volt welding voltages and for 25-, 40-, 50- or 60-cycle frequencies, it is adjustable over a range of timing from 2 to 30 cycles. Two control knobs provide for adjustment to suit the work being welded. Unit consists of an electronic tube, relay and magnetic con-

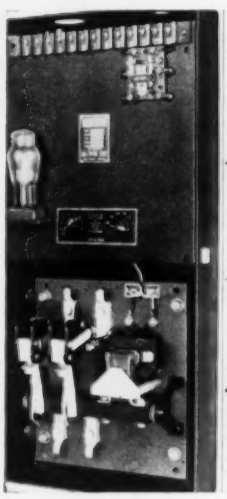


Fig. 1

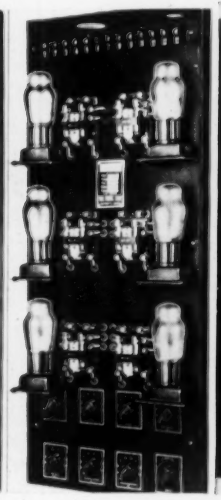


Fig. 2

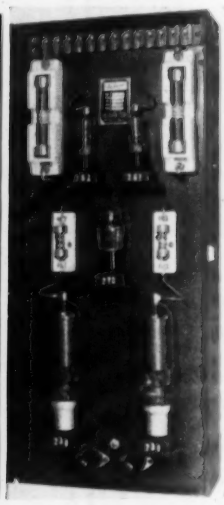


Fig. 3

tactor enclosed in a spring hinge cover case which measures approx. 11" × 13" × 30" and permits mounting either on the welder itself or on a wall or stand nearby.

"*Model 79 Weltronic Welding Timer*" (Fig. 2) is of electronic type, designed for the recently-announced process of resistance forge welding which permits the spot welding of heavy iron and steel sections and which requires a complicated sequence of accurately timed operations. This unit is designed to time virtually any combination of functions required in spot welding heavy sections wthin the scope of resstance forge welding process and can be used with any equipment capable of handling such work, whether standard or special. Eight "rapid selective type" control knobs permit welding supervisor to "dial" for proper intervals of pressure and welding current, interruptions of both, and for proper cool time following completion of actual welding. All operating elements are mounted on a panel and enclosed in a cabinet to permit mounting on either the welding machine or a separate stand. *(Continued on page 182)*

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2000 lbs. wkg. pressure.

Forged steel body

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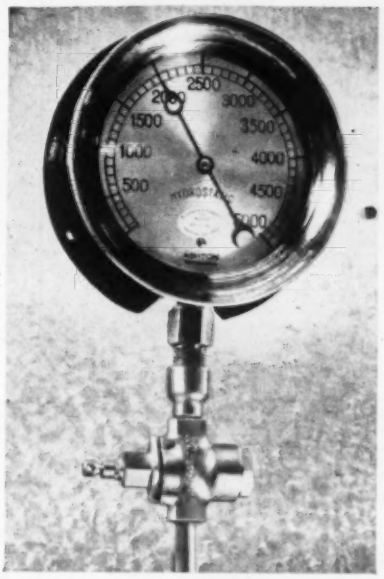

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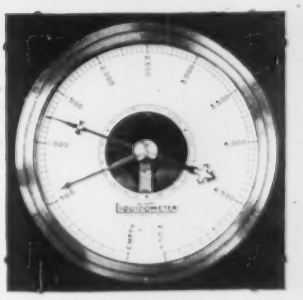

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★ *Low Temperature Rise* ★ *Roller Contact* ★ *No Distortion*

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X-Ray Apparatus
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Process Control
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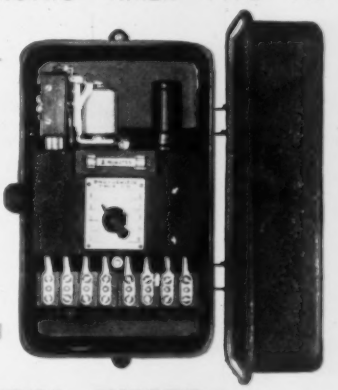
Automatic Ship Whistle Control



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The "*Weltronic Synchronizer*" (Fig. 3) makes possible starting current flow at the zero point on the current wave, provided only that the wave-form be approximately sinusoidal. It provides for absolute accuracy of weld timing, even at a thousand welds per minute, it is said.

Westinghouse Electric & Mfg. Co.

[EDITOR'S NOTE—This company manufactures extensive lines of time switches, time delay relays, etc., but *Instruments* received material on welding timers only. It is reasonable to assume that this selection was motivated by pride of achievement—the Westinghouse contributions to progress in this field of time control having been outstanding. Space limitations compelled us to summarize all too briefly the detailed technical bulletins sent us.]

I. Seam and Spot Welding Timers—General

. . . Pressure and current can be readily controlled, but it is equally important that the time of current flow be accurately controlled. When a welding time of a small fraction of a second is required by special metals or small parts, variations in timing of as little as $^1/_2$ cycle, referred to a 60-cycle power supply, may show up noticeably in the welding produced. . . . The accuracy and length of timing obtainable with contactors are usually not good enough to weld . . . materials whose welding must be critically controlled. For these, the timing is best accomplished by means of an electronic circuit which eliminates all mechanical inaccuracy and passes current during a predetermined number of cycles. This is accomplished by passing the primary current of the welding transformer directly through Ignitron or grid glow tubes. A series transformer is sometimes utilized so that the tubes can be operated at higher voltages and lower current. Timers are available which can be adjusted to pass current during a time of from $^1/_2$ to any number of cycles. . . .

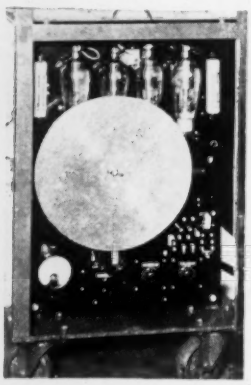

Fig. 1

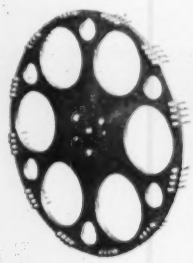

Fig. 2

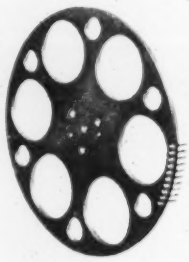

Fig. 3

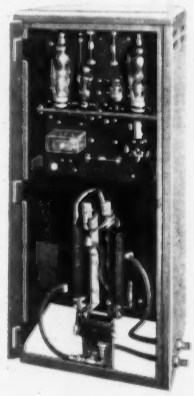

Fig. 4

II. Rotating-disk Type Seam Welding Timers

With these timers, absolutely accurate timing is assured by two characteristics: (1) Synchronous operation—The welding machine current starts and stops at zero point on current wave. This eliminates line current transients and insures high accuracy of control. (2) No moving power-carrying or interrupting parts. The timing adjustment is positive and covers a wide range of duty cycles. Industrial tubes are used throughout—not radio tubes.

The seam welding timer consists of two assemblies mounted in a common enclosing cabinet. The two units are the control panel and the Ignitron tube assembly. The control panel has all tubes and other important parts on the front for convenient maintenance and inspection. . . . In the center of the panel is a magnetic timer whose aluminum disk is driven by a synchronous motor through a speed reducer. Associated with the disk is a magnetic pickup. . . . The disk has a series of holes drilled around the edge, each hole corresponding to one half cycle of the power supply. For each half cycle of current conduction desired, a steel pin is inserted in the disk. Fig. 2 shows the disk arranged to conduct for 2 cycles and not conduct for 3 cycles. Fig. 3 shows the disk arranged to make one cycle spot per revolution which occurs in one second. Four pins in adjacent holes cause current conduction for two cycles. Provision is made for the storage of the unused pins. In order that current flow will start at the zero point on the a-c. current wave, an adjustment is provided so that the magnetic pickup may be adjusted to give the proper phase relation for the particular welding machine. The magnetic pickup consists of a permanent magnet with an air gap through which the steel pins in the timing disk pass as the disk rotates. The change of magnetic flux caused by passage of the pins through the air gap induces voltages in coils on the permanent magnet. These voltages are the timing impulses applied to the grids of the Ignitron control tubes. The *exact* time of fire for *each* half-cycle is determined by a phase shift circuit and not by the timing disk.

The standard timing disk for 50- and 60-cycle power supplies contains 120 holes for pins corresponding to 60 cycles per revolution of the disk. Combinations of timing adjustments may be obtained. Special requirements sometimes make it desirable to use a 90-pin disk which permits the use of other timing combinations.

III. Ignitron Spot Welding Timers

Class 18-335 Ignitron Spot Welding Timers function as an accurately timed single-pole single-throw switch. . . . The accurate short time obtainable with these timers . . . makes it possible to weld thin metals. . . . The timing is readily adjustable from 1 to 15 cycles on the SP-11, 1 to 30 cycles on the SP-11A, and from 1 to 24 cycles on the SP-4 and SP-4A each in one-cycle steps.

Class 18-335 Ignitron welding timers consist of one main control cabinet and will have one or two additional small cabinets containing the time and heat adjusters. . . . [Fig. 4 shows the "SP-11."] An adjustment is provided so that the customer can adjust the point on the a-c. wave at which welding current is initiated. . . . The SP-11 and SP-11A are provided with time adjusters separately mounted in a cabinet about 9" by 6¾" by 4¾". The time adjuster on the SP-11 is calibrated from 1 to 15 cycles in 1 cycle steps. The SP-11A is calibrated from 1 to 30 cycles in 1 cycle steps.

Operation—. . . Closure of the weld initiating contact energizes the initiating relay. This closes the Ignitron control circuits and also the timing tube circuit. The KU-627 tube breaks down at a definite time during the cycle determined by the setting of the power factor control. This instantly causes the KU-676 Thyratron control tubes to conduct and energize the Ignitron power tubes. At the same time a capacitor-resistor circuit is energized and after a predetermined number of cycles, depending on the adjustment, the KU-627 tube stops passing current and stops the KU-676 Thyratron control tubes. The Ignitron then stops conducting at the end of the half cycle.

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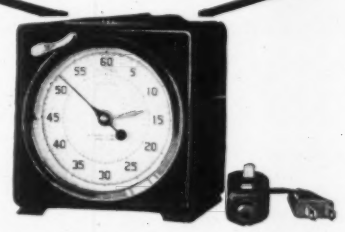

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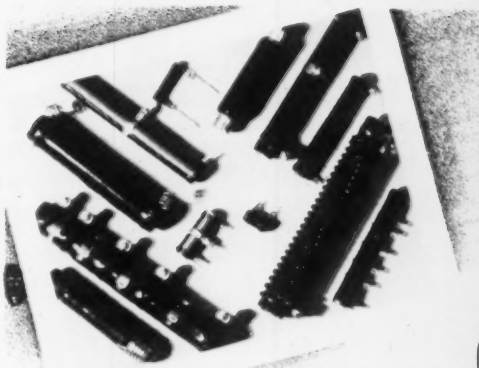

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Wheelco Instruments Co.

Time-temperature Controller

The "*Wheelco Program Control*" consists of a "Capacitrol" temperature control unit (see *Instrument*, Nov. 1935, page 304) mounted integrally with a synchronous-motor-clock-driven chart-cam type program unit. Each cam (or

"program disk" to use the company's designation) is cut to the required contour, on which rides a follower connected to the setting arm of the Capacitrol.

Continuous-repeat Controller

The "*Rheotrol*" is a continuously-repeating time-cycle switch with a standard period of one minute. Its chief application is electric furnace control. Thus, if small parts are charged into a 100-kw. furnace and a 40-kw. input is desired, dial is turned to "40" on the percent scale: current will then be on 24 sec. and off 36 sec. in each 60-sec. cycle of operation. (Result over longer period will be same as if furnace had ten 10-kw. elements, of which four were on and six off.) Standard cycle of operation is 60 sec., longer cycles available. Two models: "684" (illustrated) mercury-switch style, rated at 35 amp. 110- or 220-volt 60-cycle non-inductive load; "Model 680" consists of upper (round) part, has enclosed Micro switches, is rated at 10-amp. 110-volt or 5-amp. 220-volt 60-cycle a.c.

Zenith Electric Company

Program Clock and Process Timer

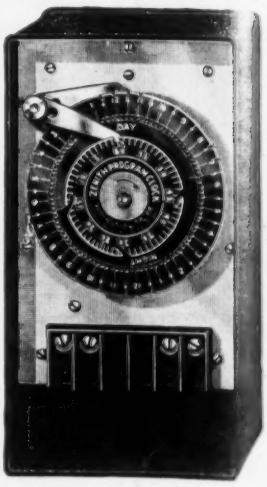

Fig. 1

As shown in Fig. 1 this instrument has two concentric dials. Both the 24-hour dial and the 60-min. dial govern the opening and closing of circuits, but contacts are made only when the preset times are reached on both dials. This makes possible one-minute settings in a 24-hour total cycle. Various models are available, affording a wide choice of signals, definite-duration closings, etc. Synchronous motors are of heavy-duty design and construction.

Process Timers

These are "repeat" type instruments with 20-, 30- or 60-min. cycles. During each cycle there is one "on" and one "off" period, but the 60-min. type may be had in a model which permits two "on" and two "off" periods. All have synchronous motors, visible dials, indicating pointers, knob adjustments and silver contacts.

Interval Timers

These are for built-in installations, requiring 2½" depth in back of the 3¼" square mounting plate. Dials are 2⅜" in diameter. Standard maximum periods are 50 sec.; 5, 20 and 50 min. Interval pointer locks in position so that resetting is not necessary if the same interval is to be repeated. Units are powered by synchronous motors. Contact arrangements are s-p. s-t. or s-p. d-t., 5 amps. per pole.

Automatic-reset Timers

These instruments are started by closing a circuit at a remote location. They return to starting position after performing the desired function. These functions are as follows: "Type S 1" will close a circuit for a preset time and then return; "Type S 2" provides a time delay for starting machinery: will close a circuit after a preset time and hold circuit closed until pilot switch is opened; "Type S 3" is similar to "S 2" with exception that it will reset after it has closed the circuit momentarily. (There are a number of other circuit combinations.) The maximum times are 50 sec.; 5, 20, 30 and 60 min.

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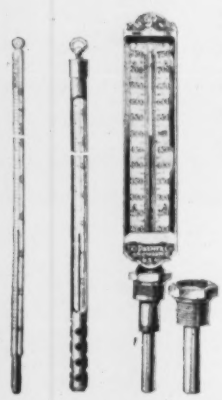

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Above is illustrated Model BK25

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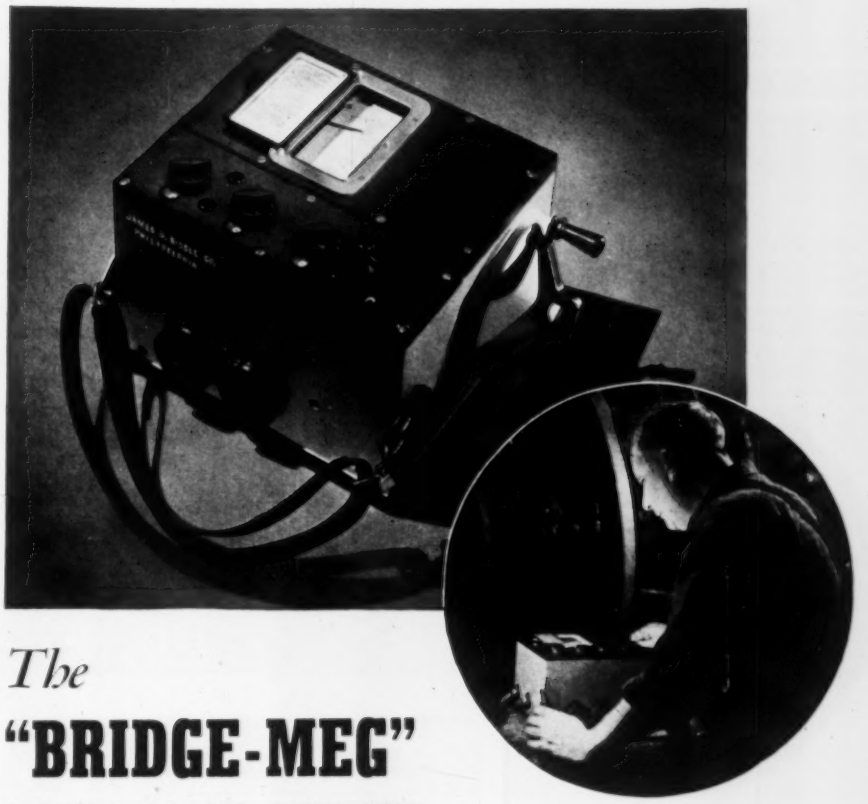

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1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

Continued from page 141 minutes—when this pressure has so dropped. (5) A main sequence which is not only halted as in (4) but which comprises a sequence-within-a sequence, this minor sequence being automatically repeated again and again until a measuring element has deflected to the predetermined point. Example, tire press cycle comprising one automatic safety test. (6) A main sequence similar to (5) but comprising two or more such minor sequences. Example, the cycle for a fully automatized press, during which two or more safety tests are made. All tests are automatic but processing conditions may dictate that one test may be made automatically over and over while another test should be made automatically once only and an alarm sounded immediately if the condition is not "right" the first time. (7), (8), etc. Combinations of the foregoing.

II. *Gradual Changes.*—(1) Constant rate of change in one direction. If produced by a cam, this cycle (ordinarily this *portion* of a cycle) may obviously be adjusted either by the slope of the cam contour, or by the cam speed, or by both. If produced by a motor, its rate is adjusted by adjusting the motor speed. (2) Constant rate of change in one direction, followed by a holding period. Since the holding period would be affected by a change in the adjustment of cam speed, the rate of increase (or decrease) is ordinarily determined by the slope of an adjustable member and the cam speed is constant. With a cam having a fixed-slope rising portion, however, the rate of change may be determined by cam speed until the desired end point is reached, whereupon this cam is declutched for a holding period timed by another cam. (3) Non-uniform rates of change in one direction or successively in opposite directions. This is generally obtained in the simplest way: by a cam especially cut to provide these successive rates of change and rotated at constant speed.

III. *Combination Cycles.*—(1) Involving non-adjustable increases or decreases in addition to the "on" and "off" actions. Refer to types under I and II. (2) Involving adjustable rates of change in addition to sequences. Such cycles usually call for careful planning, particularly in applications comprising a battery of processing equipments whose individual automatized operations must be coördinated. Example, a battery of batch-process tanks *into* which the raw product flows continuously and *from* which the treated product must likewise flow continuously, so that the battery of batch-process tanks, *as a plant*, is the equivalent of one continuous process.

* * *

That will do for the present! The instruments described in this issue certainly are triumphs of American ingenuity. But they represent also marvelous team-work between instrument makers and users. "User-acceptance" today is a far cry from 1912-18 when Victor Wichum broke the ice by installing time-temperature controllers on trial, covering the recorders with brown paper and daring his skeptical prospects to do better by "judgment, skill and experience"!

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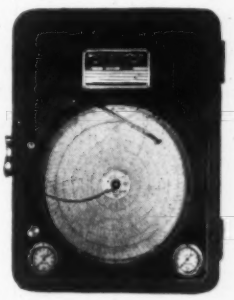

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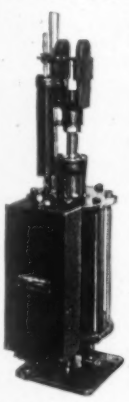

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Meteorology. By DONALD S. PISTON. The Blakiston Press, Philadelphia, 1941. Cloth, $5\frac{3}{4} \times 8\frac{1}{2}$ inches, x + 233 pages, 100 illustrations and 13 maps. Price $3.00.

This is the second (revised) edition of a quite elementary text on meteorology. The author has the valuable faculty of writing simply and graphically so that a vivid, although simplified, picture of the tools and facts of meteorology is presented. In many cases well-chosen analogies aid the beginner in understanding the phenomena under discussion. For the most part the details and qualifications which are essential for an accurate picture have been omitted. Since there probably is no general agreement among meteorogists as to what should be included in a book of this type, the choice of material made by the author should not be too severely criticized. In general the arrangement of the sections is excellent.

There are many cases of loose statements and poor choice of words, which however do not seriously detract from the overall vividness of the presentation. A number of slips have been made. Thus, the formulas on hurricane wind velocities and pressure gradient on pages 36, 129 and 141 are redundant and the data for the example on page 36 and the observed data given on page 129 do not check. Fig. 23 on page 38 should be Fig. 24; Fig. 28 on page 41 should be Fig. 30 or perhaps a figure has been omitted. In any event the order of the paragraphs in section 21 (p. 41) is not logical. On page 169-170 it is stated that Weather Bureau observations are taken at 8 a.m. and p.m., E.S.T. although the hour has been 7:30 a.m. and p.m. for several years. Fig. 1 and the text disagree slightly as to the composition of the atmosphere.

The statement is made on pages 22-23 that the commonly used gas formulas do not apply to water vapor; it may be disconcerting to the student to find that, without explanation, water vapor is assumed in the subsequent discussion to follow these same gas laws.

The mixing of c.g.s. and English units throughout the text has little in its favor. The emphasis on millibars is followed by the statement on page 36: "pressure gradient of, say, one-half centimeter per one hundred kilometers." Is the beginning student expected to know that "centimeters of mercury" is meant?

The interest of the reviewer and of the readers of *Instruments* is chiefly in instruments. There can be no quarrel with the conciseness of the treatment or the instruments selected for discussion since a full discussion of instruments is beyond the scope of the book. The importance of instruments to the budding meteorologists is such that an authoritative and careful treatment is desirable, even though brief.

Although the treatment is necessarily sketchy it could be much improved even in the space allotted. A few of the omissions and errors will be mentioned.

The section on radio sondes, in view of their present general use, is inadequate. Further, the Olland type, the only one described, is not the type commonly in use in this country.

Applying the corrections to the mercurial barometer, as is done in the text, so as to obtain only one answer, the sea level pressure at the station, is a regrettable oversight. It is important to point out to the student that correcting the barometer reading for temperature and gravity (and scale error if necessary) gives the well-known "Station pressure" and that applying "Reduction to sea level" correction to the station pressure gives the meteorological sea level pressure at the station.

The capillary error of the mercurial barometer, stated to be a constant, varies with rising and falling pressure. Since for Weather Bureau station barometers it varies only about +0.3 mb, application of this troublesome correction is ordinarily neglected.

The standard value of the acceleration of gravity is 980.665 cm/sec^2; it is not exactly the value at 45 degrees of latitude at sea level. The author (on p. 7) has the facts in reverse.

The meteorological use of aneroid barometers in ships at sea, while not mentioned, is much more important than the use cited as altimeters in aircraft and in surveying.

In Fig. 10 of a thermograph it would perhaps be more typical of practice if the bimetal were labelled "brass" and "invar" rather than "brass" and "iron."

Box kites are mentioned as being used to lift aerographs above the earth; their use has been abandoned as routine for many years in view of their danger to airplanes.

In the section on aerographs, the freezing of ink is given as the reason for the more or less common use of a stylus recording on smoked charts. Non-freezing inks are available. More valid reasons are that finer traces are obtained on the smoked aluminum chart, which is an advantage in compact short-scale instruments and further, the friction of the stylus is less than that of a pen.

The discussion of hygrometers (p. 58) should perhaps include a sentence on the electric hygrometer, development of which was announced in 1938.

The author describes the "spectro-bolometer" (p. 191) without even mentioning the spectrometer which is an essential part of the instrument.

The list of reference books would gain by the addition of Kleinschmidt's "Handbuch der Meteorologischen Instrumente."

—W. G. BROMBACHER, *Chief Aeronautical Instruments Section, National Bureau of Standards, Washington.*

Electrical Contacts. By G. WINDRED. Macmillan and Co., Ltd., London, (D. Van Nostrand Co., Inc., New York), 1940. Cloth, $5\frac{3}{4} \times 8\frac{3}{4}$ inches, xii + 103 pages. Price $4.50.

That civilization depends for its efficiency on electrical contacts may seem too broad a statement, but upon considering the fact that any device or mechanism utilizing electrical current requires a switching means, in which electrical contacts perform the primary function of opening and closing the circuit, its correctness will become evident. Operation of airplanes, automobiles, electric prime movers and automatic telephones could hardly be possible without electrical contacts. A list of instruments, devices and appliances depending for their operation on electrical contacts would be endless.

Many investigators having been led to a study of this subject, a large number of papers dealing with contacts have been published in this country and abroad during the past twenty years. Up to recently, however, this information had not been correlated for presentation to engineers and scientists who have occasion to use contacts or work with them. This first book on electrical contacts in the English language, recently written by a worker in this field for many years, meets an acutely-felt need.

The author has well arranged his treatment, describing firstly the phenomena occurring in closed contacts, then discussing joints in electrical conductors, after which he introduces in detail the subject of switch contacts. Having covered the practical aspects of the subject, he discusses circuit phenomena, describes various circuits, and explains conditions occurring when they are closed and opened. This is followed by a review of the physics of arcs and discharges. After this, a great deal of space is devoted to the theory of arc extinction and the methods employed for the suppression of arcs. The author then describes various materials used for electrical contacts and gives their physical and electrical properties. The book ends with a review of phenomena in sliding contacts, which would be of particular interest to designers of rotating electrical machinery.

It is unfortunate that the subject of arcs and discharges was allotted only 37 pages, and that some of the material presented is not fully up-to-date. Particular reference can be made to the inclusion of the empirical formula by Nottingham (page 21) of the voltage drop in an arc as a function of the arc length and of the boiling temperature of the electrode material. As long ago as 1934, Dr. Suits, working in the Research Laboratories of the General Electric Co. (*Physical Review*, Vol. 46, 1934, page 623) showed that the Nottingham formula does not hold. It can be generally stated that the author is familiar with the European literature on the subject of electrical contacts and associated phenomena but not as well with that of the United States.

The book can be highly recommended to all those who have occasion to specify contacts or are interested in the phenomena of arcing.

—S. G. ESKIN, *Director, Robertshaw Research Laboratory, Pittsburgh, Pa.*

Aeroplane Instruments — Part I. E. MOLLOY, general editor. Chemical Publishing Co., New York, 1940. Cloth, $6\frac{1}{4} \times 9\frac{1}{4}$ inches, viii + 132 pages. Price $2.00.

Aeroplane Instruments — Part II. E. MOLLOY, general editor. Chemical Publishing Co., Inc., Brooklyn, N. Y., 1941. Cloth, $5\frac{3}{4} \times 8\frac{3}{4}$ inches, viii + 132 pages. Price $2.00.

These are Vol. 2 and Vol. 15 of the "Aeroplane Maintenance and Operation Series," a new British venture which, we hear is meeting with success. In the case of these two books, we should not be astonished to learn that their popularity is largely due to that of the American aircraft instruments which are described in profuse detail.

The first eighty pages of Part I deal with the Sperry Gyropilot, Artificial Horizon and Directional Gyro; pages 81-128 with twenty indicating (non-automatic) instruments made by Smiths Aircraft Instruments Ltd.

In Part II, likewise, the automatic-control devices receive the major portion of the space, ninety pages being devoted to the Smith Automatic Pilot and its accessories; thirty pages to ten indicating instruments made by Kelvin, Bottomley & Baird Ltd., and by the Kollsman Instrument Co.; and eight pages to electrical temperature measuring instruments (evidently those made by Weston in the U. S. and by Sangamo-Weston Ltd., in England).

These space allotments probably represent the authoritative decisions of English officials responsible for the lives of R.A.F. personnel. No greater tribute could be rendered to the designers and builders of automatic-control systems than this obvious recognition: these books are primarily designed for ground crews, a slip on whose part means at least a slight annoyance for the pilot . . . and in action one false manoeuver means the deaths of all on board.

Under the General Editor's name on the title-page of each volume appears that of E. W. Knott as Advisory Editor. The prefaces in both books are signed by both these editors. Each of the prefaces gives credit to the instrument manufacturers for supplying valuable material. However, some of the text is specially written and some of the illustrations are specially made. (Even so, these volumes do not take the place of the excellent special handbooks issued by Kollsman and other American makers.)

Most of the chapters and sections begin with basic principles. It is emphasized that these must be thoroughly grasped in order to service instruments intelligently. Inspection procedures, of course, are given in detail. "Precautions" are made to stand out.

Nothing is to be found as to methods of selecting, training and supervising the ground crews . . . but only the most unimaginative clod will not detect between the lines a spirit of thoroughness and life-and-death earnestness. —M. F. [illegible]

Molecular Spectra and Molecular Structure—I. Diatomic Molecules. By GERHARD HERZBERG. Prentice-Hall, Inc., New York, 1939. Cloth, xxviii + 592 pages. Price $6.

The field of molecular spectra, or band spectra, as they are frequently called, has been accessible heretofore only to a limited number of specialists, mostly for want of a comprehensive presentation of the subject on a modern basis. The appearance of this excellent book, therefore, fills an important gap in the physical literature.

The present volume is limited to diatomic molecules, a second volume dealing with polyatomic molecules being promised. It begins with a review of the elements of atomic structure, including a discussion of the Bohr theory, the principles of the wave mechanical theory, and the vector model. The next chapter deals with the observed molecular spectra and their representation by empirical formulae and discusses the visible, ultraviolet, infrared and Raman spectra. A number of good reproductions of typical spectrograms of bands and band systems have been included in this chapter in order to give an accurate idea of their characteristic properties which serve as a basis for the theoretical discussions of the following chapters.

The third chapter contains the theory of the rotation and vibration of diatomic molecules and their relation to the infrared and Raman spectra; the next two a general discussion of electronic states and electronic transitions and their use for the interpretation of the visible and ultraviolet band spectra. Chapter VI deals with certain aspects of molecular structure, mainly electron configurations and valence, Chapter VII with dissociation and related topics, and the concluding chapter reviews the applications of molecular spectroscopy to other fields of physics, chemistry, and astrophysics.

In the theoretical treatment, the author has been successful in including just as much of the theory as is necessary for the understanding of the experimental facts, and to omit the more difficult mathematical details, for which he refers to other authors. Thus, the book can be used without extensive mathematical training. A large number of diagrams, curves, and other illustrations, as well as the clear and precise language in which the book is written, make it suitable as an introduction to the subject. At the same time, it is useful as a reference work, since it contains a complete and up-to-date table of molecular constants of diatomic molecules and an extensive bibliography.

—I. ESTERMANN, *Assoc. Professor of Physics, Carnegie Institute of Technology, Pittsburgh.*

French-English Science Dictionary — First Edition. By LOUIS DEVRIES. McGraw-Hill Book Co., Inc., New York, 1940. Flexible leather, 5 × 7 inches, viii + 546 pages. Price $3.50.

This is the best French-English science dictionary ever put out anywhere at any time. It is more than that. It is an abridged French-English *technical* dictionary — but there probably were reasons why it could not be so titled and advertised, one reason being the risk of disappointing specialists. The author was careful to explain in his Introduction: "Not all names of animals, insects, plants, or chemical compounds have been included, since each subject would make up a dictionary of its own." This limitation applies to industrial measurement-and-control technology. For example, the first French instrumentation word that came to the reviewer's mind was "diagramme," which means a recorder chart. That meaning is not given. Nor does "débitmètre" (flowmeter) appear in the French vocabulary but "flow" is given as one of the equivalents of "débit," so that in this case the user of the book will be satisfied. The same remark applies to most compound words, another example being that although "tachygraphe" is missing, "tachéométrie" and "tachymètre" are included. The reviewer (whose mother-tongue is French) spent a couple of hours trying to find serious omissions, but could not discover any. One may express the hope, however, that the author (who is Professor of Modern Languages at Iowa State College) is seeing to it that his collaborators for the next edition include a greater proportion of engineers.

What about the irregular verbs? Good news! Again quoting the Introduction: "The author has given many forms of the present, past, and future tenses as well as the past participles with at least one meaning and the infinitive form in parenthesis in case other meanings are desired. In addition to this, some five hundred common idioms have also been added, most of them based on verb forms. These idioms will facilitate the translation problems of a student who is not majoring in French."

Other correctly-descriptive extracts from the Introduction:

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"Many words have been included even though the French and the English spellings are the same or practically so. If these words were not included, the average science student would easily give up, whereas now he will take the meaning, even though spelled like the French, and refer to Webster's Unabridged or the New Standard Dictionary for further definitions. The author uses both dictionaries constantly.

"This dictionary in its compact size cannot claim completeness." (But the small size and flexible-leather binding make it easy to slip in the coat-pocket when the user goes from building to building on the campus or in the works.) —M. F. BEHAR

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Mercury Arc Rectifier Practice. By E. C. Orchard. 1936. This book is one there need be no hesitation in recommending to anyone concerned with the practical operation of rectifier plants. Cloth, 5½x8½ inches, 235 pages, $5.00.
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Theory of Alternating Current Wave Forms. By Phillip Kemp. 1935. Probably the first treatment including adequate discussions on non-sinusoidal wave forms. A standard reference. Cloth. 5½x8¾ inches, 218 pages, $4.50.
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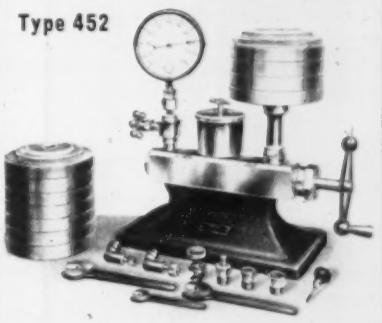

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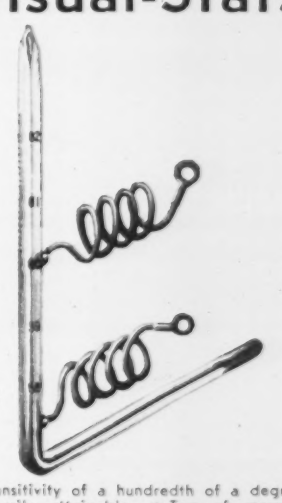

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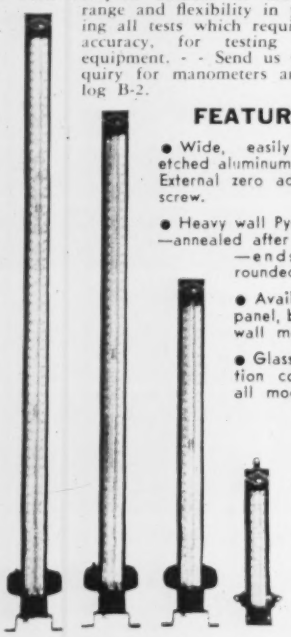

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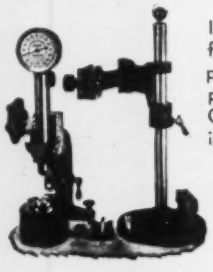

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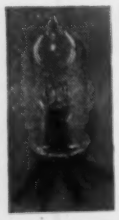

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I-193 **Plugs for Radio and Telephone Circuits.** Bulletin AI', $8\frac{1}{4}$" × $10\frac{5}{8}$", 8 pages, describes and illustrates a number of Type "AI" plugs and receptacles for aircraft and other uses, includes dimensional sketches and table of weights. Cannon Electric Development Co., 420 West Avenue 33, Los Angeles, Calif.

I-194 **Bushing Test Set.** Catalog E-54 (4), $7\frac{3}{4}$ × $10\frac{1}{2}$", 12 pages, describes new portable equipment for measuring, at a normal test voltage of 10,000 volts, the power factor and capacitance of installed bushings, insulators and other high-voltage dielectrics. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

I-195 **Pressure and Temperature Recorders.** Bulletin No. 111, $7\frac{3}{4}$" × $10\frac{1}{2}$", 24 pages, describes Type K35 recorders including a table of the different types of measuring elements. A number of typical installations are illustrated in various industries. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

I-196 **Liquid Measurement.** Bulletin, $8\frac{1}{2}$" × 11", 8 pages, discusses measurement with the King-Gage, formerly K-S Telegage, an instrument to determine the liquid level, or liquid content, of any type of tank, vat or container. King Engineering Corp., Ann Arbor, Mich.

I-197 **Automatic Control.** Bulletin 42, $8\frac{1}{2}$" × 11", 4 pages, describes device for automatically controlling the input of power, heat, or flow of liquids or gases to any process or equipment. Lindberg Engineering Co., 221 North Latlin St., Chicago, Ill.

I-198 **"Cenco News Chats."** April 1941, $7\frac{3}{4}$" × $10\frac{3}{4}$", 24 pages, covers items on synchronous timer, mixing device, light sources, polarimeter, high-vacuum pump and other laboratory apparatus. Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.

I-199 **Plugging Control.** Bulletin GEA-3571, 8" × $10\frac{1}{2}$", 4 pages, describes and illustrates plugging-control equipment—the new plugging-switch, also shows eight ways to apply the switch. General Electric Co., Schenectady, N. Y.

I-200 **Air Compressors.** Bulletin H-620-BSC, 8" × $10\frac{1}{2}$", 8 pages, describes and illustrates balanced angle type compressors for industrial service—single-stage and two-stage. Worthington Pump & Machinery Corp., Harrison, N. J.

I-201 **Tank Temperature Control.** Condensed Catalog, $8\frac{1}{2}$" × 11", 6 pages, describes and illustrates low water cut-offs, thermostatic tempering valve, boiler water filter, water hammer and vibration eliminator. The Van Norstrand Co., Inc., 119 East 27th St., New York City.

I-202 **General Radio "Experimenter."** April 1941, 8 pages, contains articles on "New Terminals for use with Coaxial Transmission Lines" and "A New Audio-Frequency Microvolter." General Radio Co., 30 State St., Cambridge, Mass.

I-203 **Potentiometer Controllers.** Bulletin A-286, Folder, covers automatic temperature controller with Type B drive-unit recommended for group-drive of as many as five controllers. A number of illustrations of typical installations are included. Foxboro Co., 46 Neponset Ave., Foxboro, Mass.

I-204 **Non-Inductive Resistances.** Cat. No. 1, Sec. B5, $8\frac{1}{2}$" × 11", 4 pages, describes and illustrates "Ohm-spun" resistor units and meter and relay loads covering list prices of the various types. The States Co., Hartford, Conn.

I-205 **Strip-Chart Recorders.** Bulletin 570, 8" × $10\frac{1}{2}$", 16 pages, describes and illustrates d-c ammeters, milliammeters, voltmeters, millivoltmeters, pressure gages, liquid level gages, recording thermometers, tachometers, flowmeters, mechanical motion recorders and Metameter system of telemetering. The Bristol Co., Waterbury, Conn.

I-206 **Valve Positioner.** Sheet, $8\frac{1}{2}$" × 11", 1 page, describes and illustrates new valve positioner for diaphragm valves which provides for the optional use of a by-pass valve which is made as an interchangeable unit. Moore Products Co., 3629 N. Lawrence St., Philadelphia, Pa.

I-207 **Tension Dynamometers.** Bulletin, $8\frac{1}{2}$" × 11", 2 pages, describes and illustrates tension measuring instruments for determining the pound pull on power, transmission, cable, messenger and guy strand wires. W. C. Dillon & Co., Inc., 5410 West Harrison St., Chicago, Ill.

I-208 **Magnetic Indicator Base.** Booklet, $3\frac{1}{2}$" × $5\frac{1}{2}$", 4 pages, covers base for dial test indicators consisting of Alnico magnet, equipped with a removable upright post of non-magnetic metal. Mellaphone Corp., 714 University Ave., Rochester, N. Y.

I-209 **Production Counter.** Catalog Section No. 16, $8\frac{1}{2}$" × 11", 2 pages, describes and illustrates new magnetic counter operated by photocell and a beam projector. The interruption of the light beam by an object actuates the electric counter. Durant Mfg. Co., 1929 North Buffum St., Milwaukee, Wis.

I-210 **Centrifugal Hand Tachometers.** Sheet, $8\frac{1}{2}$" × 11", 1 page, shows tachometers, 5-range with rotating gear-shift. Speed ranges are changes by rotating the barrel head until the range seen just below the knurling is in the center over the dial and snaps into position with an audible click. Coats Machine Tool Co., Inc., 110 West 40th St., New York City.

I-211 **Recording Potentiometer for Glass Lehrs.** Bulletin No. 22-32, describes multi-record potentiometer for glass lehr temperatures and speed. Records of the glass lehr belt speed and the temperatures of lehr heating zones are combined on one chart. Brown Instrument Co., 4482 Wayne Ave., Philadelphia, Pa.

I-212 **Recording Instruments.** Catalog Section 43-415, $8\frac{3}{8}$" × $10\frac{3}{4}$", 12 pages, describes and illustrates a-c and d-c. ammeters and voltmeters in switchboard, wall and socket mounting portable types. The ammeters are available in ranges from 5 to 125 amperes and the voltmeters in ranges from 90-140 to 450-500 volts. Dept. 7-N-20, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

I-213 **Cornell-Dubilier "Capacitor."** Vol. [illegible] Nos. 2 & 3, each 16 pages, contains articles entitled "Service for Fidelity" and Part 2 of "Killing the Hum-Bug" and list of new dial settings. Cornell-Dubilier Electric Corp., New Bedford, Mass.

I-214 **Liquid Level Control.** Bulletin [illegible], 8½" × 11", 4 pages, describes and illustrates Faratron electronic control—no floats, no moving parts, non-mechanical—an electronic switch for controlling level of water, syrup, oil, milk, etc., in any type of container open or closed. Jamenite Electric Co. 407 South Dearborn St., Chicago, Ill.

I-215 **Oil Testing Instruments.** Catalog No. 699E, 8½" × 11", 32 pages, describes and illustrates 100 types of oil testing instruments—new and improved petroleum testing apparatus for acid heat, gum stability, Ramsbottom carbon residue, grease consistency, kinematic viscosity, flash and fire, etc. C. J. Tagliabue Mfg. Co., Park & Nostrand Aves. Brooklyn, N. Y.

I-216 **"The Laboratory."** Vol. 12, No. 4, 6" × 9", 96 pages, contains article on the manufacture of burettes, items on electrically operated device which imparts a gyrating motion to a platform upon which flasks, bottles and similar containers can be attached and a new laboratory instrument for measuring refractive index and other laboratory devices. Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.

I-217 **Sulphur Determination Apparatus.** Bulletin C-140, 8½" × 11", 4 pages, describes and illustrates shell-design quartz tube sulphur determination apparatus; also assay distillation unit and shell-design kinematic viscosimeter bath. Braun Corp., 2260 East 15th St., Los Angeles, Calif.

I-218 **Low Power Photomicrography.** Catalog F-19, 8½" × 11", 4 pages, describes and illustrates micro tessars and tessar IIb lenses designed for low power photomicrography. Price list attached. Bausch & Lomb Optical Co., 615 St. Paul St., Rochester, N. Y.

I-219 **General Radio "Experimenter."** May 1941, 8 pages, contains two articles entitled "Radio Frequency Characteristics of the Type 726-A Vacuum-Tube Voltmeter" and "The General Radio Standardizing Laboratory." General Radio Co., 30 State St., Cambridge, Mass.

I-220 **"The Hydromike."** Vol. IV, No. 3, 8½" × 11", 4 pages, contains feature article discussing Stevens simplified venturi meter, brief description of box compass and item on keeping recorders dry. Leupold, Volpel & Co., 425 N. E. 70th Ave., Portland, Oregon.

I-221 **Engineering Data Covering Resistors and Controls.** Loose-leaf Binder, 9" × 11½", 44 pages, contains data sheets on resistors, controls and resistance devices for the radio, television, electronic, electrical and aeronautical industries. Clarostat Mfg. Co., Inc., 285 North 6th St., Brooklyn, N. Y.

I-222 **Terminal Blocks.** Cat. No. 1, Sec. 6, 8½" × 11", 4 pages, describes and illustrates Type NT terminal blocks designed to provide a junction between switchboard wiring and cable wires, available in from one to sixty poles making them suitable for a wide range of applications. The States Co., Hartford, Conn.

I-223 **Temperature Control.** Bulletin No. 12-6, 8¾" × 11½", 8 pages, describes and illustrates tipper temperature control system for automatic can filling machines. Brown Instrument Co., 4482 Wayne Ave., Philadelphia, Pa.

I-224 **Smoke Indicators.** Bulletin 413, 8½" × 11¾", 4 pages, describes and illustrates super sensitive visual type smoke indicators for guarding against objectionable smoke and indication of proper combustion hazes; and automatic combustion control with the Hazegage combustion indicator. Ess Instrument Co., 30 Irving Pl., New York City.

I-225. **Electrical Connecting Devices.** Catalog No. 11, 20 pages, covers complete line of multi-contact plugs and sockets, terminals, terminal panels, fuse mounts, etc. Howard B. Jones, 2300 Wabansia Ave., Chicago, Ill.

I-226 **Glass-Electrode pH Indicator.** Catalog E-96(2), 7¾" × 10½", 8 pages, describes and illustrates portable pH indicator for laboratory and plant application, said to retain accuracy up to 85°F. in atmospheres of 95% relative humidity and measurements to be made consistently within its limit of error of adjustment, ±0.1pH. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

I-227 **Mercury Relays.** Bulletin 140, 8½" × 11", 8 pages, describes and illustrates plunger type mercury relays with hermetically sealed, non-fusable, non-oxidizing contacts. Typical contact ratings for time delay and quick acting contacts shown. The Adams & Westlake Co., Elkhart, Indiana.

I-228 **Viscosimeter.** Bulletin GEA-3618, 8" × 10½", 2 pages, describes and illustrates Zahn viscosimeter for control principally of the viscosity of finishing materials, such as paint, varnish, lacquer or japan. General Electric Co., Schenectady, N. Y.

I-229 **Tool Chests.** Bulletin, 8½" × 11", 4 pages, announces new line of machinists' tool chests of solid oak, leatherette or a low priced line of poplar. Prices of the various chests included. George Scherr Co., Inc., 128 Lafayette St., New York City.

I-230 **"Solving Industrial Crimes."** Case No. 27, 4" × 5½", 16 pages, covers speed recorders and indicators, recording ohmmeters, time recorders, relays or contact making instruments, pressure recorders, portable current transformers and other recording instruments in maker's line. The Esterline-Angus Co., Inc., Indianapolis, Ind.

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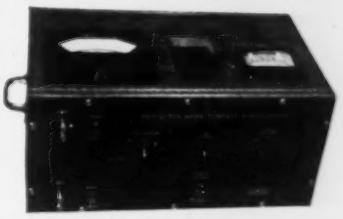

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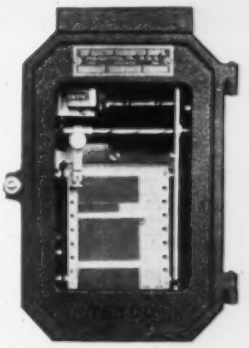

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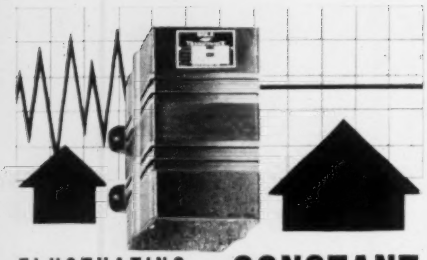

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